ASTRONOMY®

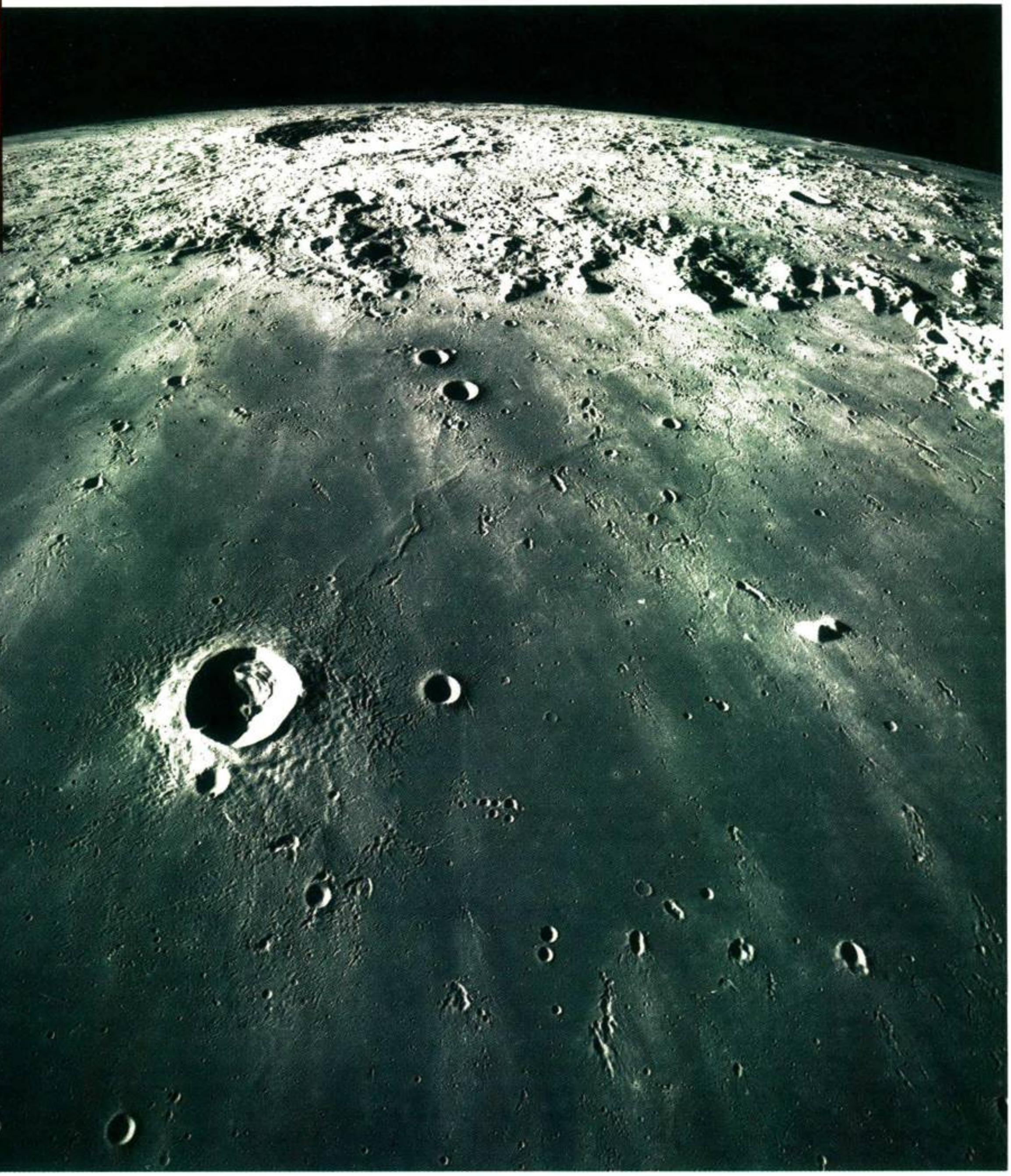
April 1992 **U.S. $2.95**
U.K. £1.75
Can. $3.50

RETHINKING THE BIG BANG

How To Build Your Own Observatory

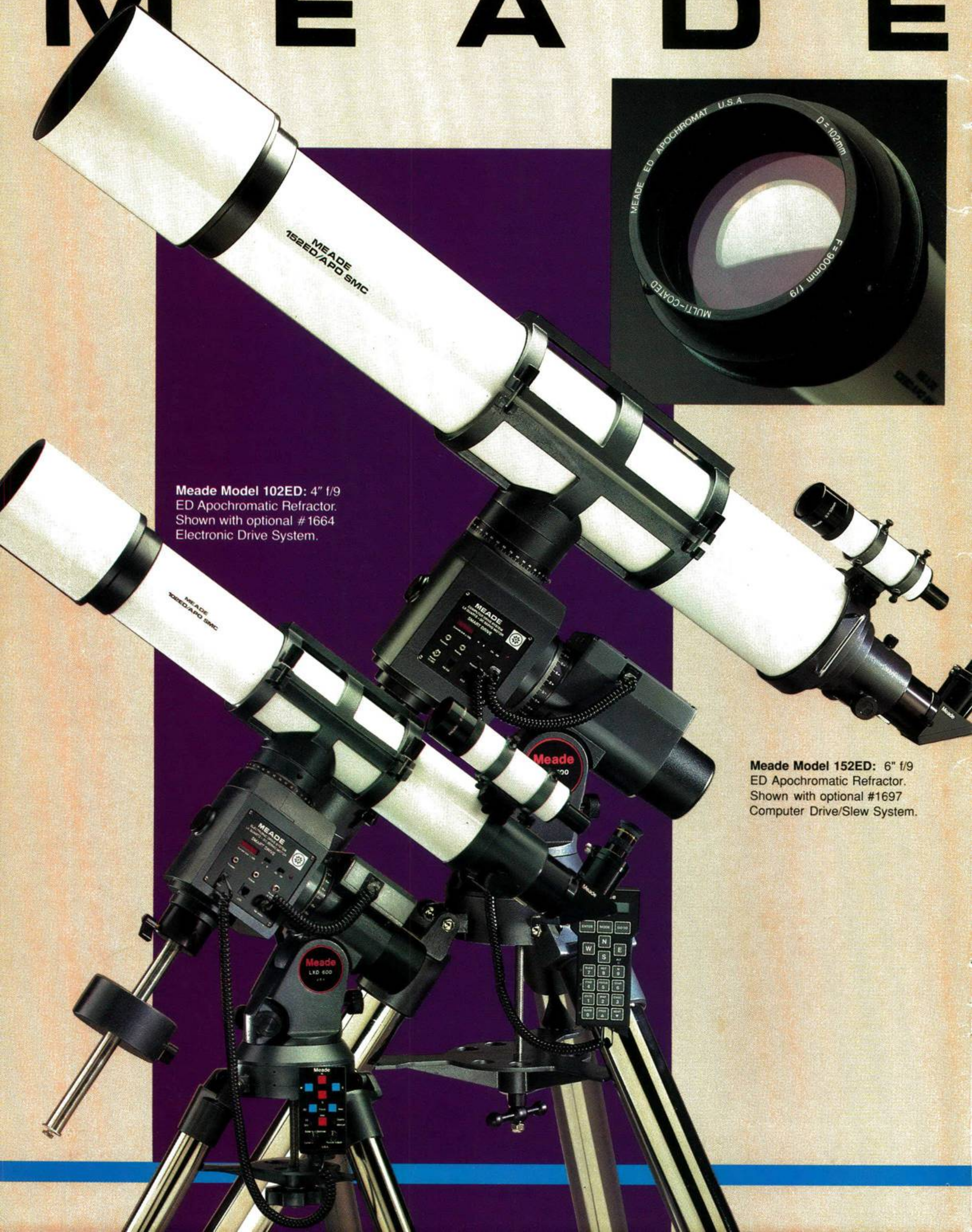
Eclipse Spectacular at Sunset

ICD 08070



Lunar Rays: Full-Moon Delight

MEADE®


MEADE ED APOCHROMAT U.S.A.
D = 102mm
F = 900mm f/9
MULTI-COATED
MEADE 152ED/APO SMC
MEADE 102ED/APO SMC
MEADE SMART DRIVE
Meade LXD 600
ENTER MODE GOTO
N W S E

Meade Model 102ED: 4" f/9 ED Apochromatic Refractor. Shown with optional #1664 Electronic Drive System.

Meade Model 152ED: 6" f/9 ED Apochromatic Refractor. Shown with optional #1697 Computer Drive/Slew System.

ED APOCHROMATIC REFRACTORS

The finest optical imaging performance obtainable, combined with the most advanced equatorial mounts ever made available.

Have you ever wished you could observe with an instrument that yields the finest, textbook-perfect star images obtainable from any telescope? *Now you can.*

Meade USA-made ED Apochromats combine absolutely uncompromised image quality with a level of equatorial mounting precision, stability, and sophistication heretofore only dreamed of by the advanced amateur. *If you're looking for the most nearly perfect, ultra high resolution, high-contrast images of the skies that astronomical instrumentation—of any type—can provide, then a Meade apochromatic refractor is for you.*

Optical Designs—Each 4", 5", 6", and 7" Meade apochromat includes an f/9 objective lens doublet with ED-glass (Extra-low Dispersion) rear element. Corrections for chromatic and spherical aberrations, for coma and astigmatism, and for lateral distortion are as faithful to optimized design criteria as can be obtained in any telescope. The front element of each objective is 2-side **Super Multi-Coated (SMC)** for maximum light transmission and image contrast.

Optical Tube Assemblies include the new Meade #684 giant rack-and-pinion focuser, with eyepiece-holders for both 1.25" and 2". The large 2.7" I.D. focuser sleeve permits the use of either 35mm or large-format professional camera bodies.

High-Contrast Baffling—Every Meade apochromat main tube includes a series of ***ten or more*** internal field stops and light baffles that effectively eliminate any stray light reaching the focal plane. Images of breathtaking sharpness, resolution, and contrast leap out against an extremely dark-sky backdrop.

Equatorial Mountings—As important to the serious observer as superb imaging performance, all-new state-of-the-art Meade LXD 600 and LXD 700 equatorial mountings will revolutionize forever the way amateur astronomers think about telescope mounting platforms. Consider:

- ■Massive polar and declination castings with oversize thrust surfaces.
- ■Worm-gear tracking and microfine manual slow-motion controls in both RA and Dec.
- ■*Eight* sealed ball bearings *(4 on each axis!)* carry even heavy loads with supreme precision.
- ■Superstable field tripods, including a new Meade Giant Field Tripod with 6" and 7" APO models.

MEADE
COMPUTER DRIVE SYSTEM
LX QUARTZ - DC SERVO MOTOR
SMART DRIVE
Current (mA x 100)
N
S
On
Off
Focuser
Reticle
Power 12 VDC
RS 232
Keypad
RA Motor
CCD
Encoders

Optional Electronic Drive Systems—Two new dual-axis, DC-servo-motor-controlled electronic drive systems are available for the LXD 600 and LXD 700 mounts; both drive systems fully integrate internally to either mount:.

■ ***#1697 Computer Drive/Slew System:***

Four dual-axis drive speeds for (a) photoguiding corrections (at **2x** sidereal rate); (b) image centering and microslewing in the main telescope (at **32x** sidereal rate); (c) image centering in the viewfinder (at **2° per second**); and fast-slewing of the telescope across the skies (at **8° per second**). Use the keypad controller to switch speeds instantly as you move the telescope electronically with a pointing accuracy never before available.

Permanently programmable (PPEC) Smart Drive™ capable of reducing RA periodic drive errors to 5 arc secs. or less.

Digital Readouts on both telescope axes, read from the handheld Electronic Command Center.

GO TO Capability: Enter the RA and Dec of an object, punch GO TO, and the telescope automatically slews on both axes at 8° per second to the object, centering it in the field.

747-Object Built-in Library: Enter any of the 110 Messier objects, 278 of the finest NGC objects, 351 stars (doubles, variables, polar alignment stars), or one of the 8 major planets from Mercury to Pluto; punch GO TO, and the telescope automatically slews to the object. For $99* add the optional Meade 8000-object CNGC library to the software (a 30-second plug-in).

Keypad operation of virtually every telescope function, from tracking rates to the crossline brightness of an illuminated reticle eyepiece.

Polar alignment of the Mount: Quick (less than one minute) and precise, using the 2-star method.

■ ***#1664 Electronic Drive System***—For users not requiring the microprocessor-controlled capabilities of the #1697 Computer Drive, the #1664 system includes 2 dual-axis drive speeds (**2x** and **32x**); permanently programmable (PPEC) Smart Drive; object tracking-rate control, including quartz-controlled sidereal rate; and other features.

Complete ED Apochromatic Refractors

Specifications—Each complete telescope includes: optical tube assembly with #684 giant 2.7" focuser, 8 x 50mm viewfinder, #930 2" diagonal mirror with 1.25" adapter, and Super Plössl 26mm eyepiece; 4" and 5" models include the LXD 600 equatorial mount and standard field tripod; 6" and 7" models include the LXD 700 equatorial mount and giant field tripod; each mount is provided with manual slow-motion controls, analog setting circles, and locks on both axes.

Special Introductory Pricing Through 5/31/92*:

Model 102ED:	4" f/9 ED/APO complete	**$1795.**
Model 127ED:	5" f/9 ED/APO complete	**2295.**
Model 152ED:	6" f/9 ED/APO complete	**3995.**
Model 178ED:	7" f/9 ED/APO complete	**4995.**

Drive Systems

#1664	Electronic Drive System	**$295.**
#1697	Computer Drive/Slew System	**595.**

Optical Tube Assemblies (OTA's)

Each OTA includes complete tube assembly with #684 giant 2.7" focuser. Supplied without viewfinder or accessories.

Model 102ED/APO-OTA:	4" f/9	**$1075.**
Model 127ED/APO-OTA:	5" f/9	**1595.**
Model 152ED/APO-OTA:	6" f/9	**2295.**
Model 178ED/APO-OTA:	7" f/9	**2995.**

Equatorial Mountings

LXD 600 Mount & Standard Field Tripod	**895.**
LXD 700 Mount & Giant Field Tripod	**1995.**

■ *Prices shown are suggested USA mail-order retail prices and do not include sales taxes or shipping, if applicable.

■ The 1992 Meade General Catalog—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.

■ **For further information on Meade ED Apochromatic or Schmidt-Cassegrain telescopes, or on any Meade product, call Meade Instruments toll-free at 1-800-854-7485 (in Calif. 714-556-2291), or contact one of these authorized mail-order dealers:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-878-9577; Info.: 510-447-9570.

SCOPE CITY/Mail-Order Dept., Simi Valley, CA.
Orders: 800-235-3344; Calif. & Info: 805-522-6701

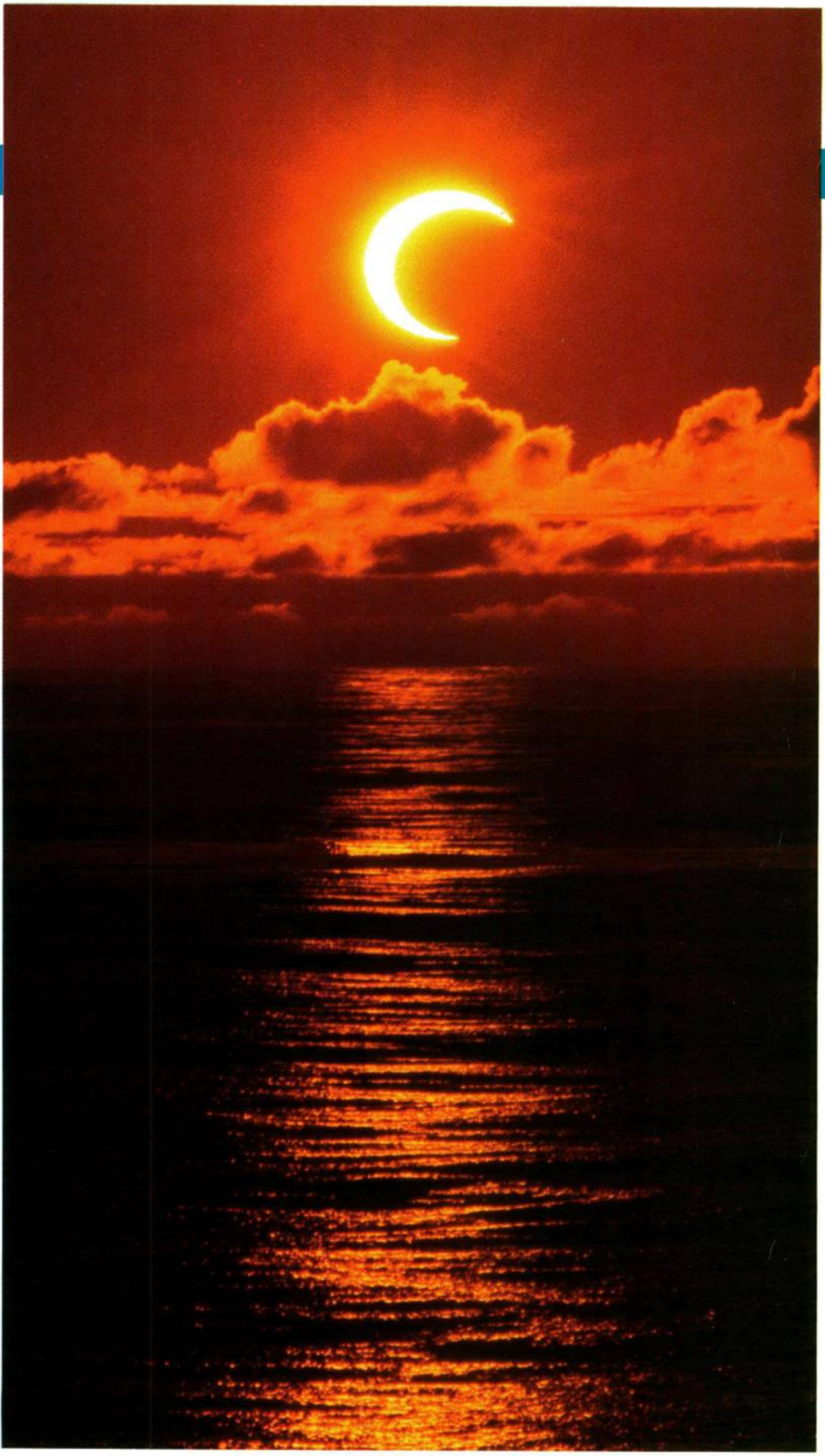
SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

Canada:

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291
'AX: (714) 556-4604

©1992



JANUARY'S SUNSET ECLIPSE provided highly spectacular views from southern California south into Mexico. Feast your eyes on a wealth of eclipse photos beginning on page 68. Photo by Joe Reed taken from 200 miles south of Ensenada, Mexico.

ON THE COVER: A splatter of lunar rays radiates northward from the great crater Copernicus (horizon) in this metric camera image taken from the Apollo 17 command module. The prominent crater in the foreground is Pytheas. See page 80 for information on how you can observe lunar rays. NASA photo #AS-17-M-2444.

ASTRONOMY®

April 1992 **Vol. 20, No. 4**

30 Beyond the Big Bang

New observations suggest that theories of how the universe formed may need revision. By Jeff Kanipe.

38 Three Nights on Kitt Peak

Learn what it is like to observe with one of the world's largest telescopes. By Dave Bruning.

46 Mysterious Sungrazers

These comets plunge into the Sun and are more common than once believed. By Gerrit Verschuur.

50 ASTRONOMY Sky Almanac

60 How to Collimate Your Telescope

Easy steps to proper telescope alignment will keep images sharp and clear. By Michael Porcellino.

68 Ring of Fire

On January 4, viewers on the West Coast witnessed a sunset they'll never forget. By Richard Talcott.

74 Building Owl Observatory — Part 1

Here's how to build your own backyard observatory from the ground up. By Jim Krick.

80 Explore the Lunar Rays

Full Moon and nothing to look at? Guess again! By Edmund Fortier.

85 Comets for the Big Dobs

Take on a new deep-sky observing challenge — tracking down this summer's crop of faint comets. By Norman Carlson.

Departments

6 **Behind the Scenes**
6 **Letters**
13 **Viewpoints**
Paul Revere's Ride
20 **AstroNews**
Neutrino News
22 **Space News**
Exploring the Ultraviolet
24 **Amateur News**
Okie-Tex '91
89 **Reader Reports**
Jupiter and Saturn
94 **Astronomy Books**
99 **AstroBytes**
Distant Suns for Windows
104 **New Astronomy Products**
108 **Meetings and Events**
112 **Readings and Resources**
112 **Credits**
114 **Advertiser Index**

ASTRONOMY (ISSN 0091-6358) is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Editorial telephone: (414) 796-8776; Advertising and Dealer Orders: (800) 558-1544; Customer Service inquiries: (800) 446-5489 weekdays 8:30 a.m. -5:00 p.m. Central Time; Consumer product and subscription orders: (800) 533-6644 7 days a week, 24 hours a day; Fax (414) 796-0126. Copyright ©1992 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second-class postage paid at Waukesha, WI, and additional mailing offices.. Allow six to eight weeks for new subscriptions and changes of address. New subscriptions start with the current issue. Subscription price: 1 year, $24. All foreign: add $6 per year; please remit in U.S. funds. GST #R122713209. Send editorial and business inquiries and submissions to the address above. Not responsible for unsolicited materials. ASTRONOMY is indexed in The Reader's Guide to Periodical Literature. Microfilms of ASTRONOMY available from University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, MI 48106. Printed in the U.S.A. POSTMASTER: Send address changes to ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Canadian second-class postal permit no. 545775.

The Audit Bureau

Behind the Scenes

CONTROVERSIAL THOUGHTS ABOUT THE BIG BANG

The moonless nights of April provide a quiet interlude between the showy skies of winter and those of summer. Both those seasons sparkle with the nebulae and glittering stars of the Milky Way. But on April evenings, the Milky Way encircles the horizon, and the constellations show just a handful of naked-eye stars as they parade across the sky. It's only natural to shift our perspective outward into the cosmos.

Lying millions of light-years behind the stars of Virgo and Coma Berenices is a distant cluster of galaxies. To astronomers, the Virgo cluster is just one among countless others they have found in the universe. As cosmologists survey greater volumes of space, they find more and more clusters of galaxies and clusters of clusters in ever-larger structures. The cosmos seems grandly ordered on the most sweeping scale imaginable.

Up to a point. When surveys reach the 3° background radiation thought to be the fading echo of the Big Bang itself, there is no visible structure at all: the cosmic background is perfectly smooth. A big question cosmologists now seek to answer is How did all the structure emerge from such a smooth explosion? Most astronomers believe the answer will not radically change the traditional Big Bang model of how the universe formed. But a small minority of cosmologists disagrees vehemently. Our lead feature focuses on this growing cosmological controversy (see page 30).

From reports we received about January's spectacular annular eclipse, Southern California observers had a suspenseful hide-'n-seek game with sunset clouds. Checking weather reports, we watched a storm approach and weren't sure there would even be an event to report on. Luckily, the coast was clear to the south of Los Angeles. And in the end, as photo after photo rolled in, we had a hard time choosing just which ones to print (page 68). Our deepest thanks go to each of you who hustled those photos to us.

Another exciting feature this month is the first in a 3-part series on building an observatory. If you've ever dreamed of creating that special place where you and your telescope can explore the heavens, Jim Krick's Owl Observatory has lots of good ideas to feed your imagination (page 74).

One final thought. In all of April's dark skies, don't overlook the Full Moon. As its cold brilliance floods the sky around midmonth, take the opportunity to explore the delicate tracery of the lunar rays (page 80). These splashes of molten and powdered rock mark the freshest craters — and because the rays can be seen best only at Full Moon, surprisingly few observers ever become familiar with their beauty.

Sincerely,

Robert Burnham
Senior Editor

ASTRONOMY

Robert Burnham Senior Editor
Rhoda I. Sherwood Managing Editor
Alan Dyer Associate Editor
David J. Eicher Associate Editor
David H. Bruning Associate Editor
Richard Talcott Assistant Editor
Tracy Staedter Editorial Secretary
Christine Reel Secretarial Assistant

Thomas L. Hunt Art Director
Jane B. Lucius Art Director Admin.
Patti L. Keipe Graphic Designer
Steven Davis Technical Designer

Walter J. Mundschau President
Robert A. Maas Publisher
Charles Post Circulation Director
George A. Gloff Executive Art Director
William R. Edgar Managing Art Director
Karin O. Frederickson Production Director

Daniel R. Lance Advertising Director
Gregory J. Swan Advertising Sales Manager
Catherine Odland Advertising Sales Representative
Advertising Department: (800) 558-1544

U.S. Newsstand Distribution
I.C.D., The Hearst Corp., New York, NY 10019
Canadian Newsstand Distribution
Telemedia Dist., Toronto, Ontario M4S3B3
World Newsstand Distribution
Curtis Circulation Co., Hackensack, NJ 07601

Letters

So Close and Yet So Far

The article in the November issue about the great Leonid meteor storm sparked my memory about some observations I had made when I just started in the hobby. However, I only just learned of my feat of ill-timed observing 25 years later.

When in the sixth grade in southern California, I decided to become a stargazer. I didn't own a telescope or even binoculars, so I used white paper and a black felt-tipped pen to draw crude sky maps of what I saw with the naked eye. I figured I would take my maps to the library and compare my maps with those in astronomy books to learn the constellations.

Patiently I drew what I saw, not knowing that these objects were Orion, Taurus, Gemini, and Leo. When I was finished, I signed and dated my maps and stored them away. Over the years I kept my first sky maps to remember these humble beginnings.

The date mentioned in Ken Croswell's article sounded familiar, so I rummaged through my belongings until I found my maps. Sure enough — I had one dated November 17, 1966. I had missed the Leonid meteor storm by only 17 hours. — *Kelley Dupuis, American Embassy, Abidjan, Ivory Coast, West Africa*

Use Secondary Diameter or Area?

While reading the article "ASTRONOMY Tests Affordable Reflector Telescopes" in the December issue, I noticed that Alan Dyer states that a 2" diagonal in a 6-inch telescope produces a 33-percent obstruction. Shouldn't he use the area rather than the diameter of the diagonal to compute the obstruction? — *Don Redfield, Andover, Connecticut*

— You should use area if your main concern is the reduction of light-gathering power. However, we follow the tradition of telescope makers and optical designers and quote the obstruction as a function of diameter. Image contrast is affected by diffraction caused by the secondary. The larger the secondary, the more light is diffracted into the rings of the Airy disk — the bull's-eye pattern seen when you look at a star at high power — which reduces the image contrast. High contrast is important, for example, for seeing fine details on planetary disks.

Our Galaxy's Rotation

The article "Shedding Light on Dark Matter" by Richard Monda (February

Genesis Owner Turned Into Zombie!

Gentlemen:

I would like to say a few words about my new Genesis. I live in a relatively light polluted area, and own an 8" SCT which I have used for about two years. During this time there have been many deep sky objects which I have been unable to locate from my back yard.

I bought Genesis because I wanted a telescope that I could set up quickly to use at home on week-nights. When I began using Genesis, a few weeks ago, I was surprised to find many objects that have eluded me during the past two years. I was even more surprised when I realized that I had been looking in the right places all the time. These objects showed up in Genesis, but not in my 8" SCT.

My back yard experience with Genesis encouraged me to take it to my dark sky observing site which is, at an elevation of 5000 feet above sea level, in the Sierra Nevada Mountains. What I saw there was, in many cases, better than photographs in magazines. I was able to resolve globular clusters to a greater degree than publications indicate.

I didn't expect Genesis to be this good. It really is better than I imagined.

There does seem to be one problem with Genesis. My short week-night observing sessions have become anything but short, and I frequently arrive at work feeling and looking very much like a zombie. I guess that no telescope can solve all of your problems. In any case, thanks for the ones you did solve.

- George N. Storm, California

Photo by Jim Riffle

Unsolicited comments from warranty cards

- *It's beautiful, from case to scope.* C.C. The Netherlands
- *Fantastic! Great photo resolution, best optics ever owned and I'm a Hasselblad & Nikon fan. Now my best item.* D.B. New Jersey
- *This is my 1st scope and I'm having a wonderful time finding the limits of the instrument and my locating abilities.* G.P. New Jersey
- *Very pleased with your new improvements.* J.F. California
- *Even though cost was more than an 8" SCT with mount, quality & convenience won out. I will only use Tele Vue optics, mount and accessories.* W.B. Indiana
- *The telescope lives up to its expectation.* T.W. England
- *Wanted a 2nd telescope that was portable, delivered wide fields and superb images. Genesis is all I hoped for. The sharpness is astonishing and it's very portable.* G.H. Canada
- *Sold my 8" SCT looking for better images.* P.F. New York
- *Fantastic! My wife could not see Trapezium etc. with old scope. Now can't get her away from eyepiece: you have right to be enthused about your product.* W.J. Canada
- *I just wanted to have one excellent telescope to do astrophotography. Fantastic. Awesome.* J.J. California
- *Beautiful equipment - Total satisfaction with first use. Keep up the good work.* M.C. Ohio
- *I wanted a very high quality refractor. I was told by many - "This is it." This is a beautiful instrument!* M.F. Florida
- *Remarkable! I always wanted a 4" fluorite refractor. Sold my (8" SCT).* T.S. Indiana
- *Compactness & quality - a beautiful, fantastic instrument.* J.V. The Netherlands

- *It's the best 4" refractor made.* A.A. California
- *I was looking for the best first telescope I could buy. Something small. I never saw images clearer and more distinct than in Genesis.* G.D. Canada
- *Genesis is the only scope in the race. I wanted the best and believe I got it.* E.S. Australia
- *As the apparent equal of a (Maksutov), with the added RFT capability, Genesis is 'the', to me, obvious choice for portable astronomy. I'm completely satisfied.* R.A. Georgia
- *Very Impressive - my first view was of Pleiades with a 40mm Wide Field. The observation was remarkable, crisp, bright and jewel-like.* P.L. Massachusetts
- *The best on the market.* E.B. England
- *I bought this telescope without having seen it in-person, based on its specification & your reputation for quality. As usual, I got more than I expected with Tele Vue products...* K.L. Texas
- *My friend borrowed it & won't give it back!!* T.L. Canada
- *I wanted portability and very high quality optics. I have waited many years to be able to afford this telescope, - it was worth waiting for.* P.H. Australia
- *Superior to other 4" scopes on offer.* Z.V.S. South Africa
- *Had SCT, poor contrast/resolution. Tele Vue just the opposite, also it's more portable.* W.S. Connecticut
- *I purchased this instrument because:*
  1) Apo-refractor - basic design
  2) Tele Vue reputation
  3) Dealer owns same model
  U.B. Canada
- *Genesis is as good as gold...Maybe better!* F.G. California
- *I compared specs of Tele Vue vs (other high performance refractors); T-V best choice for $.* R.A. New Hampshire
- *Magic.* C.H. England

My sincerest thanks to all who've written us with such kind comments. I look forward to reading yours.

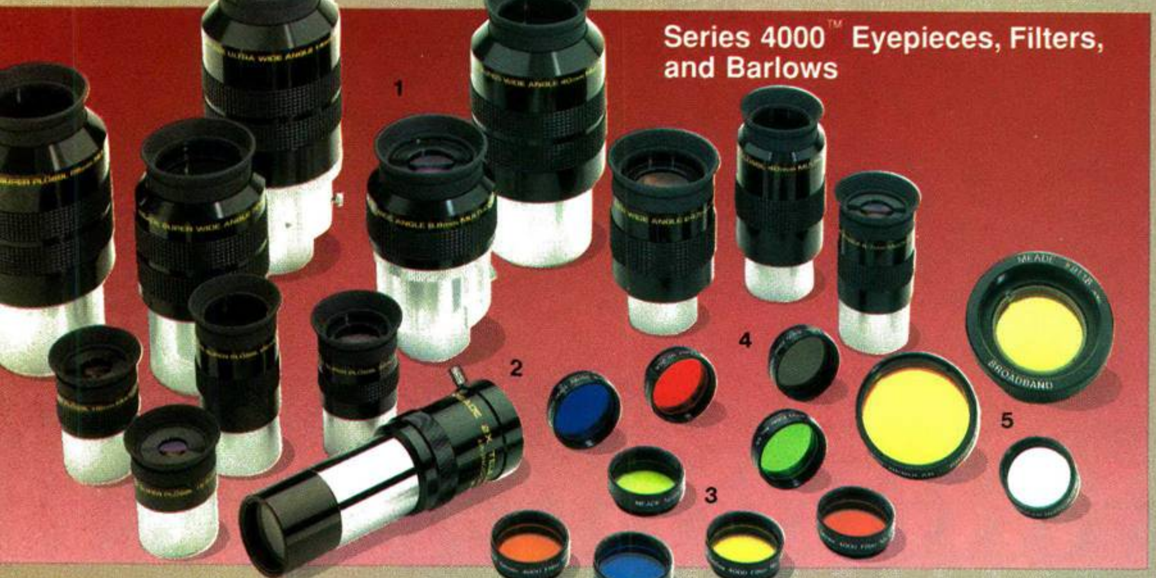
Al Nagler

Tele Vue

20 Dexter Plaza
Pearl River, NY 10965
(914) 735-4044

GENUINE MEADE ACCESSORIES & PARTS

Series 4000™ Eyepieces, Filters, and Barlows



1 The World's finest telescope eyepieces now include rubber grips and soft rubber eyeguards for an even better observing experience! All eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Best of all, **Meade Series 4000's are guaranteed to deliver more field, more contrast, and more image sharpness than any other brand at any price, or your money back.*** For splitting the closest doubles, revealing tenuous, faint nebulosity in deep-space, or studying hairline lunar and planetary detail, Meade multi-coated Series 4000's are the oculars that serious observers insist upon. ***"Clearly the best."***

Super Plössls (5-elements; 1.25"; 52°):
6.4; 9.7; 12.4; 15; 20; 26mm ea **$79.95** (2.49)
32mm(52°); **40mm**(44°); each **99.95** (2.49)
56mm (52°, 2") **219.95** (3.18)

Super Wide Angles (6-elements; 1.25"; 67°):
13.8mm: 129.95 (2.49) **18mm: 139.95** (2.49)
24.5mm: 159.95 (2.49) **32mm**(2"): **229.95** (3.18)
40mm(2"): **279.95** (3.18)

Ultra Wide Angles (8-elements, 1.25"; 84°):
4.7mm: 147.95 (2.49) **6.7mm: 187.95** (2.49)
8.8mm(1.25"/2"): **219.95** (3.18)
14mm(1.25"/2"): **249.95** (3.18)

*at participating dealers; see catalog for details.

2 **#140: Series 4000 2x Apochromatic Barlow Lens** (1.25")--The original Meade 3-element, air-spaced, multi-coated design. Absolutely unmatched in image resolution and color correction. 28mm dia. lens (26mm clear aperture). **$69.95** (2.49)

3 **Series 4000 Photo-Visual Color Filters** (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast on the Moon and planets . Thread into virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue.
each **$12.95** (1.79)

Set #1—4 filters: #12 Yellow, #23A Lt.Red, #58 Green, #80A Blue **$42.95** (2.49)

Set #2—4 filters: #11 Yellow-Green, #25A Red, #47 Violet, #82A Lt. Blue **$42.95** (2.49)

Set #3—4 filters: #8 Lt. Yellow, #21 Orange, #38A Dark Blue, #56 Lt. Green . **$42.95** (2.49)

Sets #1 & #2—8 filters **$82.95** (2.49)

Sets #1, #2, & #3—12 filters **$118.95** (3.18)

4 **Series 4000 Moon Filter** (1.25")—Excellent for 4" to 12" telescopes. Reduces Moon brightness by 87%. **$14.50** (2.49)

5 **Series 4000 Nebular Filters**—The very latest in multi-layer interference coating technology, Meade premium nebular filters are guaranteed to be the finest obtainable at any price. Use a Series 4000 Broadband filter to block most forms of light pollution, with minimal attenuation of desired wavelengths. Use a Narrowband filter in heavily light-polluted areas, or for extremely high contrast observing of faint nebulae.

BROADBAND FILTERS

#908B (1.25")—Threads into all Meade 1.25" eyepieces, and virtually all other brands. Full 26mm clear aperture. **$67.95** (1.79)

#910B—Threads into all Meade 2" eyepieces and most others; 44mm dia. **99.95** (2.49)

#911B--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **87.95** (1.79)

NARROWBAND FILTERS

#908N (1.25")—Threads into virtually all 1.25" eyepieces; 26mm clear aperture. **89.95** (1.79)

#910N—Threads into all Meade 2" eyepieces and most others; 44mm dia. **119.95** (2.49)

#911N--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **109.95** (2.49)

Rack-and-Pinion Focusers (1.25")

The finest focusers in the industry, Meade rack and pinion mechanisms have precise, ultra-smooth action along the entire travel distance. Housings are machined for tight fit of the moving sleeve. All focuser models may be used on tubes of from 4" to 20" diameter; all accept 1.25" eyepieces. Mounting hardware included.

#71—The finest economical focuser available. Travel distance: 2.2". A precision mechanism, beautifully finished. **$44.95** (2.49)

#67—Includes spring-loaded gearbox for variable tension adjustment. Travel distance: 2.2". **59.95** (2.49)

Rack-and-Pinion Focusers (2")

#680--The most popular 2" focuser ever manufactured. Thousands in use. Spring-loaded gearbox; 3" travel. Includes 1.25" and 2" eyepiece-holders. **89.95** (3.48)

#682—Low-profile 2" focuser; body height only 1.75". Spring-loaded gearbox. Travel: 2.5". Includes 1.25" adapter. **99.95** (3.48)

Viewfinders: 30mm, 50mm, 60mm

#637: 6 x 30mm--Fine, 7° wide-field finder; coated, achromatic lens; crosshair eyepiece. 2-ring bracket with alignment screws. Attaches to tube diameters 6" to 12" **$39.95** (2.79)

#545: 8 x 50mm--*(lower photo)* Wide 5° field; coated achromatic objective; crosshair eyepiece. White tube. Ideal for telescopes of any aperture. See bracket below. **59.95** (3.48)

#544: 8 x 50mm--Same as #545, but in Meade blue. **59.95** (3.48)

#957: 9 x 60mm--*(top photo)* Collects 44% more light than 50mm; superior for faint objects; bracket below. **89.95** (3.78)

Bracket for 8 x 50mm: Fits Meade and Celestron SCT's, and other tubes from 7" to 20" diameter. **17.95** (1.79)

Bracket for 9 x 60mm: Fits tubes from 7" to 20" diameter. Removable dovetail included. **22.95** (1.79)

Multi-Coated Giant Binoculars

Superb, fully multi-coated 11 x 80mm and 20 x 80mm Giant Binoculars, ideal for wide-field deep-space observing. **Rubber-coated bodies for rugged field use!** BAK-4 prisms yield bright, sharp, high-contrast images. Hard carry case, tripod adapter included.

11x80: $359.95 (4.87)
20x80: $379.95 (4.87)

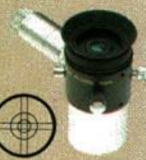
45° Erect-Image Diagonal Prisms

Originally developed by Meade Instruments, these convenient diagonals erect the astronomical image, for terrestrial use of astronomical telescopes. Fully coated.

#927: for .965" focusers.
#928: for 1.25" focusers.
#931 Hybrid: accepts 1.25" eyepieces, fits .965" focusers.

Specify model desired. each: **$49.95** (2.49)

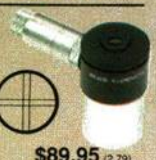
World's Most Advanced Illuminated Reticle Eyepiece



Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Internal batteries included. Multi-coated optics. Bullseye reticle. 1.25" **$119.95** (2.79)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator. **$99.95** (2.79)

MA 12mm Illuminated Reticle Eyepiece



Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Includes wireless red LED illuminator with internal batteries and variable brightness control. **$89.95** (2.79)

MA 12mm--Same as above, but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator. **$69.95** (2.79)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory, with 1.25" eyepiece adapter **$89.95** (2.79)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-Mount, available separately.

.965": $24.95 (2.49) **1.25": $29.95** (2.49)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-Mount for your camera. **$39.95** (2.49)

Tele-Extenders

For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Use with T-Mount for your camera.

Basic Tele-Extender: *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos. **$26.95** (2.49)

Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece. **$36.95** (2.49)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera. **$26.95** (2.49)

2X Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25" **$47.95** (2.49)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated. 1.25" **$59.95** (2.49)

Orthoscopic Eyepieces (1.25")

Fine 4-element oculars that yield excellent image quality with any telescope. Computer-optimized design provides wide, flat fields, highly corrected for spherical and chromatic aberrations. Parfocal, multi-coated 1.25" barrels. Threaded for filters. **Focal Lengths: OR 4, 6, 9, 12.5, 25mm.**

each **$47.95** (2.49)

Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, the 3-element MA gives sharp, faithful, well-corrected images of the Moon, planets, and deep-space. Multi-coated; threaded for filters. 1.25". **Focal Lengths: MA 9, 12, 25, 40mm.**

each **$37.95** (2.49)

HOW TO ORDER

- Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.
- Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.
- Meade accessories may be ordered from any Meade Advanced Products dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE CO., Burbank, CA
Orders: 800-843-4780; Info: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828. Info: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-878-9577. Info: 510-447-9570.

SCOPE CITY/Mail-Order, Simi Valley, CA.
Orders: 800-235-3344; Info/CA:805-522-6701

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Info/IL: 312-332-2000.

Canada:

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

©1992

MEADE®

Complete 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from **$499.95**!

MEADE
MEADE
Meade
Meade
Meade

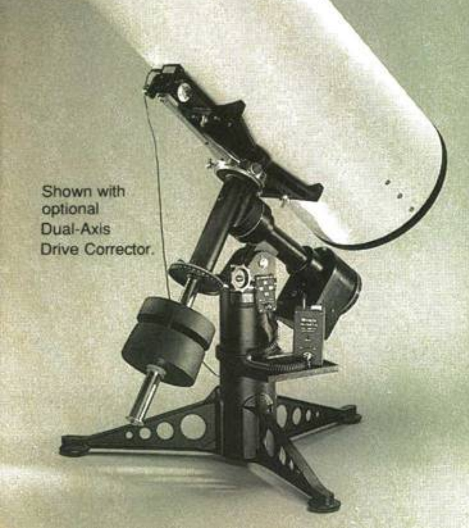
6" f/8 $499.95

8" f/6 $599.95

10" f/4.5 $699.95

Starfinder 16: 16" f/4.5 $1995.

See the Meade General Catalog for details.



Shown with optional Dual-Axis Drive Corrector.

STARFINDER™

REFLECTING TELESCOPES

Meade Starfinder 6", 8", and 10" reflecting telescopes offer the finest values available anywhere. **Standard equipment on all 3 models includes:**

- **Superb Optical System:** Includes a Meade hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of fine-annealed Pyrex® glass.
- **Precision Equatorial Mount:** Manufactured of virgin aluminum castings machined to tolerances of .001" or better, and placed atop a 4"-dia. pier with die-cast tripod legs, yielding rock-solid support for the optical tube assembly. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint sky objects directly from their catalogued coordinates.
- **Electric Motor Drive** (115v./60Hz) with 6 ft. power cord: Permits fully automatic tracking of celestial objects; plugs into any standard outlet.
- **Accessories and Components:** Meade Starfinder telescopes include high-performance components throughout: **#71 Rack-and-Pinion Focuser** (1.25") for smooth, backlash-free focusing of the image; a coated achromatic **#637 6 x 30mm Viewfinder** with crosshair eyepiece and 7° field, for quick object-locating; **coated MA 25mm** (1.25") eyepiece; strong, durable spiral-wound **optical tube** with attractive white finish; and **cast aluminum mirror cell** for accurate mounting and alignment of the primary mirror.
- **Optional Accessories:** See the opposite page for some of the many optional accessories available. Additional systems, including the **#55 Manual Declination Control**, **#43 Drive Corrector** and **#47M Dual-Axis Drive Corrector,** are described the **Meade General Catalog.**

A Meade Starfinder telescope opens up the skies to an extremely wide range of serious visual observing, to lunar and planetary photography, and even to limited deep-space photography. And every telescope is backed by the World's largest manufacturer of serious telescopes.

- **Packing & UPS Shipping Charges to any address in the 48 states: 6"--$50; 8"--$60; 10"--$75.**
- Prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.
- **The 1992 Meade General Catalog—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.**
- **For further information call Meade Instruments toll-free at 1-800-854-7485 (in Calif. 714-556-2291) or contact one of these authorized *mail-order* dealers:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828. Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-878-9577; Info.: 510-447-9570.

SCOPE CITY/Mail-Order Dept., Simi Valley, CA.
Orders: 800-235-3344; Calif. and Info.: 805-522-6701.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

Canada:

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders and Information: 416-783-4140.

ADVANCED PRODUCTS DIVISION **Meade Instruments Corporation**

LX200 SCHMIDT-CASSEGRAINS

Legendary Meade SC optics and the largest, most rigid, most advanced fork mounts in commercial Schmidt-Cassegrain history.

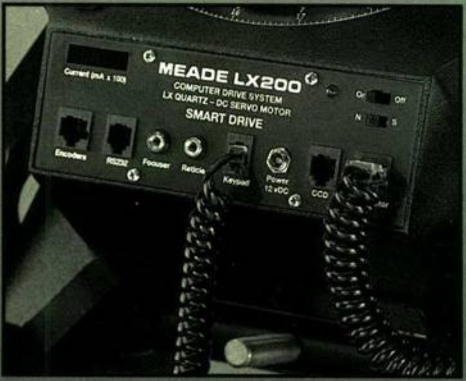
Now you can buy the most advanced 8" and 10" Schmidt-Cassegrains ever produced, at a price directly competitive with other SCT's offering only a fraction of the features!

Meade LX200 SCT's offer a revolutionary departure from any other SCT's ever made available. Consider the **standard specifications** of these telescopes:

New Heavy-Duty Fork Mounts—The largest, most rigid in the industry. *Meade 8" and 10" LX200 fork mounts yield the lowest damping times of any SC fork mounts available.* Large 4"-diameter polar ball bearings complemented by DC-servo-motor-driven worm gears on ***both*** telescope axes permit observatory-level precision in tracking, guiding, and slewing.

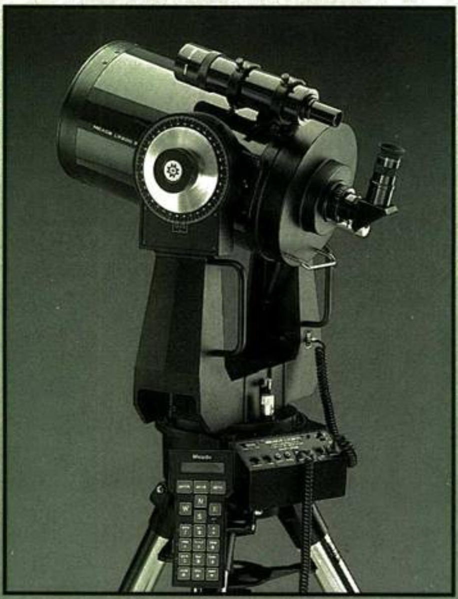
100% Computer-Controlled Operation—All-new Meade LX200 microprocessor-controlled drive systems offer an incredible array of features:

- **Four-speed operation on both telescope axes** simultaneously, including (a) photo-guiding (at **2x** sidereal rate); (b) image centering and microslewing in the main telescope (at **32x** sidereal rate); (c) image centering in the viewfinder (at **2°** per sec.); or fast-slew of the main telescope across the skies (at **8°** per sec.).
- **Pushbutton Electric Slew**—Press RA or Dec slew, east or west, north or south, and the telescope moves at 8° per sec. on both axes. As you near a desired object, flip to 2° per sec. slew, to center the object in the field. The observer need never touch the telescope in moving from one object to another. (Of course, if you wish, the telescope may be moved manually as well.)



- **Digital Readouts** on both axes, read from the handheld Electronic Command Center (ECC).
- **GO TO Capability**—Enter the RA and Dec of an object into the keypad of the ECC, press GO TO, and the telescope automatically slews to the object at 8° per sec., centering it in the field.
- **747-Object Built-in Library**—Enter any of the 110 Messier objects, 278 of the finest NGC objects, 351 stars (doubles, variables, polar reference stars), or one of the 8 planets, from Mercury to Pluto, press GO TO, and the telescope slews at 8° per sec. to the object with uncanny precision. For $99* add the 8000-object Meade CNGC library, a 30-second plug-in.
- **Permanently programmable (PPEC) Smart Drive™**, capable of reducing periodic drive errors to 5 arc. sec. or less.

Legendary Meade Super Multi-Coated f/6.3 or f/10 Schmidt-Cassegrain Optics—Now you can choose either wide-field f/6.3 or classical f/10 Meade US-made SC optics **at the same price.** Either way, you'll be buying the finest Schmidt-Cassegrain optical system available, a system that yields razor-sharp stellar images and high-resolution observing of the Moon, planets, and deep-space, from the World's leading manufacturer. Meade exclusive Super Multi-Coatings on both sides of the correcting plate assure maximum light transmission and contrast.



Altazimuth Mode Operation—For all visual observing applications, and for lunar and planetary photography, Meade LX200's may be set up in the altazimuth mode, without any equatorial wedge—just attach the telescope's drive base directly to the tripod, use the fast 1-star alignment procedure, and the telescope's computer actuates 2-axis tracking that keeps objects precisely centered in the field, even at high powers, during the entire observing session. For long exposure photography (longer than about 5 minutes) altazimuth-induced field rotation requires an equatorial wedge, which may be purchased separately.

Fast Polar Alignment—Center two reference stars in the telescopic field and the telescope's computer tells you exactly what telescope controls to actuate for precise polar alignment in the equatorial mode in less than a minute.

The widest array of keypad and power-panel control functions—In addition to the microprocessor-controlled operations listed above, the handheld ECC and the telescope's power panel permit: readout of sidereal or local time; actuation of the optional electric focuser; crossline brightness control of an illuminated reticle eyepiece; direct plug-in of popular CCD autoguiders/imagers; and more than 14 other telescope functions.

MEADE LX100 SCHMIDT-CASSEGRAINS

Observers not requiring the sophistication of the LX200 electronics may wish to consider an 8" or 10" LX100 model SCT instead. Meade LX100's include the exact same heavy-duty fork mounts of their LX200 counterparts, but with a microfine declination tangent arm control in place of the LX200's motorized worm gear, and with a 2-speed drive in place of the LX200's 4-speed drive; optical tubes and coatings are identical. Standard LX100 features include:

- Handheld Electronic Command Center—With 2-speed operation, **2x** for photo-guiding and **32x** for image centering and microslewing in the main telescope. (With the optional DC-servo declination motor installed, these speeds are operational on both telescope axes.)
- Permanently programmable (PPEC) Smart Drive, as described above.

Complete LX100 and LX200 Telescopes

Specifications: 8" and 10" LX200's—Each complete telescope includes: 8" or 10" SC optical tube assembly (specify f/6.3 or f/10) with super multi-coatings; heavy-duty fork mount, with 4" polar ball bearing, dual-axis 5.75" worm-gears, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; handheld keypad Electronic Command Center, with digital readout display, PPEC Smart Drive, four-speed drive control on both axes, GO TO controller, and 747-object software library; 25 ft. power cords for telescope operation from either 12 v. DC auto cigarette lighter plug or 115v.AC; 8 x 50mm viewfinder with crosshairs; diagonal prism (1.25"); Series 4000 Super Plössl 26mm eyepiece; variable-height field tripod; new deluxe die-cut-foam-fitted carrying case; complete operating instructions.

Specifications: 8" and 10" LX100's—Each complete telescope includes 8" or 10" SC optical tube assembly (specify f/6.3 or f/10) with super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, 5.75" RA worm gear, and multi-function power panel display on the drive base; manual slow-motion controls on both axes; handheld pushbutton Electronic Command Center with PPEC Smart Drive and 2-speed drive control; 25 ft. power cords for telescope operation from either 12v. DC auto cigarette lighter plug or from 115v. AC; viewfinder: 6 x 30mm (8") or 8 x 50mm (10"); diagonal prism (1.25"); Series 4000 Plössl 26mm eyepiece; variable-height field tripod; equatorial wedge (8") or Superwedge (10"); new deluxe die-cut-foam-fitted carrying case; complete operating instructions.

Special Introductory Pricing Through 5/31/92*:

Supplied complete, per above specifications:

8" LX200 Schmidt-Cassegrain	**$1995.**
Equatorial Wedge 8"	**110.**
10" LX200 Schmidt-Cassegrain	**2295.**
Superwedge 10"	**395.**
8" LX100 Schmidt-Cassegrain with wedge	**1695.**
10" LX100 with Superwedge	**2395.**

- *Prices shown are suggested USA mail-order retail prices and do not include sales taxes or shipping, if applicable.
- For dealer or catalog information see the Meade **ED Apochromatic Refractor** ad in this issue.

ADVANCED PRODUCTS DIVISION

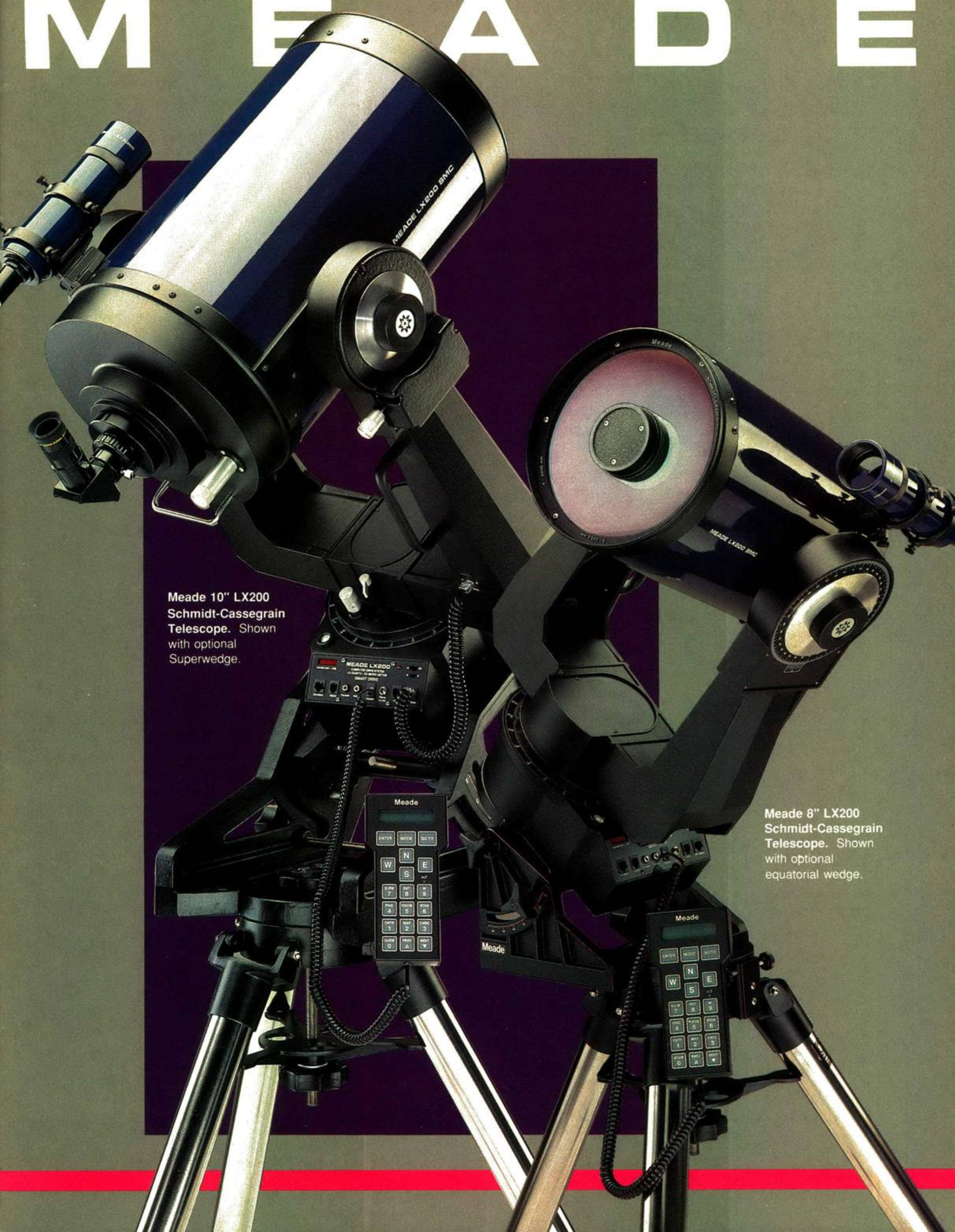
Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur

1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291
FAX: (714) 556-4604

©1992

MEADE®


MEADE LX200 SMC
MEADE LX200
SMART DRIVE
Meade
ENTER
MODE
GO TO
N
W
E
S
Meade
MEADE LX200 SMC

Meade 10" LX200 Schmidt-Cassegrain Telescope. Shown with optional Superwedge.

Meade 8" LX200 Schmidt-Cassegrain Telescope. Shown with optional equatorial wedge.

METEORITES!

Irons. Stones. Stony-irons. Tektites.
Quality display and study specimens.
Space jewelry, books, slides.
Authenticity guaranteed.
Color Catalog $2.

Bethany Sciences
P.O. Box 3726-A
New Haven, CT 06525
CATCH A FALLING STAR!
(203)393-3395

The StarHunter I

- Double Truss Tube 12" or 13.1"
- Convert your 13.1" Tube
- Disassembles for Moving
- $369 and up

Send $2 for illustrated info and "The Underground Astronomer" newsletter. - Bob Cusick

Cusick Telescopes
P.O. Box 256 719-395-8253
Buena Vista, CO 81211

UNIVERSE 92
June 20-22, 1992
University of Wisconsin - Madison

A two-day event for amateur astronomers. Presented by the Astronomical Society of the Pacific and ASTRONOMY magazine.

UNIVERSE 92

For more information and a registration packet write:
Wisconsin Meeting Information
A.S.P., 390 Ashton Ave., San Francisco, CA 94112
or call (415) 337-1100

ASTRONOMY CAMPS FOR ADULTS AND STUDENTS

The University of Arizona in Tucson, Arizona—*"The Astronomy Capital of the World"*—is proud to present astronomy camps for teenagers and adults.

Activities include:
Lectures by astronomers from the UA Steward Observatory ∗ Viewing and photography of celestial objects through 40", 60" and 61" telescopes on Mount Lemmon ∗ Tour of Mirror Laboratory ∗ Lectures and films on topics from the solar system to cosmology ∗ Application of computer and engineering technologies.

Camp Dates
Adults: April 24-26
Teens (Basic): June 5-12
Teens (Advanced): June 19-26

Cost
Adults: $275
Teens: $485

To register:
Call Lisa Roubal at 1-800-232-8278
(In Arizona: 602-621-5233)

THE UNIVERSITY OF ARIZONA ALUMNI ASSOCIATION

1992 issue) stated that our Galaxy rotates like a rigid wheel. But then it said that the stars in the Galaxy move at 150 miles per second, regardless of their distance from the center of the Galaxy. A rigid wheel requires that distant objects move faster than objects closer to the center. If the stars move at constant speed about the Galactic center, then they cannot be moving like a rigid wheel. — *Ying C. Wen, Athens, Ohio*

— Mrs. Wen is right: our Galaxy does not rotate as a rigid wheel. The illustration on the bottom of page 46 correctly shows the rotational velocities of the stars. The text should have read that the innermost one or two kiloparsecs of the Galaxy rotate like a rigid wheel, and that the outer regions rotate with constant speed.

The Cost of Getting Started

I disagree with Richard Hill's Viewpoints essay in the December issue. Sure, telescopes today seem expensive, but they seemed so when I was a child, too. Where does it say that a beginner must have a high-quality telescope with which to begin? Using a low-cost telescope, I personally "discovered" sunspots, Saturn, and Jupiter with a thrill that has never been matched using larger telescopes. Although some of us dislike so-called department store telescopes, most amateurs I know started with such instruments.

If we are concerned about where future astronomers will come from, perhaps we should look elsewhere for a solution. We could make our first telescopes available for use by newcomers who have joined our clubs. We could all become more involved in the education of the public by acquainting them with the night sky. Then the growth and continuation of our hobby will not be determined by the price of a telescope. — *Kreig McBride, Bellingham, Washington*

New is not an absolute necessity in this hobby. Unlike the case with some hobbies where "used" means worn out or obsolete, a used telescope remains useful for many years. Used telescopes may be found in many places: want ads, garage sales, club swap meets, and ASTRONOMY's Readers Exchange. I have obtained several telescopes this way and was able to work my way up to larger telescopes.

To help others get their first look through a telescope, our club has started a "telescope library" of new and used parts. From the parts that have accumulated, we have built several telescopes. These scopes are available to anyone in our area to borrow.

Experienced stargazers should pass on the knowledge of affordable telescope making. Astronomy will continue to grow and flourish because people like you and me spread the joy of our hobby to others. — *Bob Duke, Boring, Oregon*

Richard Hill bemoans the high cost of getting started in astronomy. I believe, however, that the cost of getting started has never been lower than it is now. For example, Hill's RV-6 cost $200 in 1965. Adjusting its price for inflation, this telescope would cost over $700 today. This is the same price you would expect to pay for a good quality 6- or 8-inch telescope today. And these scopes may be of better quality than the RV-6.

Schmidt-Cassegrain telescopes cost about the same as they did 20 years ago. The price of this telescope represented about 26 percent of the average annual per capita income in 1970. Today, it represents only about 10 percent. So it seems that Mr. Hill's high cost is really a myth. — *William Fusfield, Pittsburgh, Pennsylvania*

Using a telescope of my own making to view the heavens has been a great thrill. The anticipation of the first views through the telescope builds during the construction period and carries over into many future star parties and observing sessions.

So my suggestion to Mr. Hill is to encourage someone to make a telescope. Better yet, start a telescope making workshop or mirror grinding class. You can still build a 6-inch Newtonian for a few hundred dollars. But it's up to us experienced telescope builders to show newcomers how to do it.

Young people can learn about setting circles, clock drives, and polar alignment later. They want to look at the Moon and the rings of Saturn. So help them to see the most they can through their telescope. — *Bruce Swayze, Portland, Oregon* □

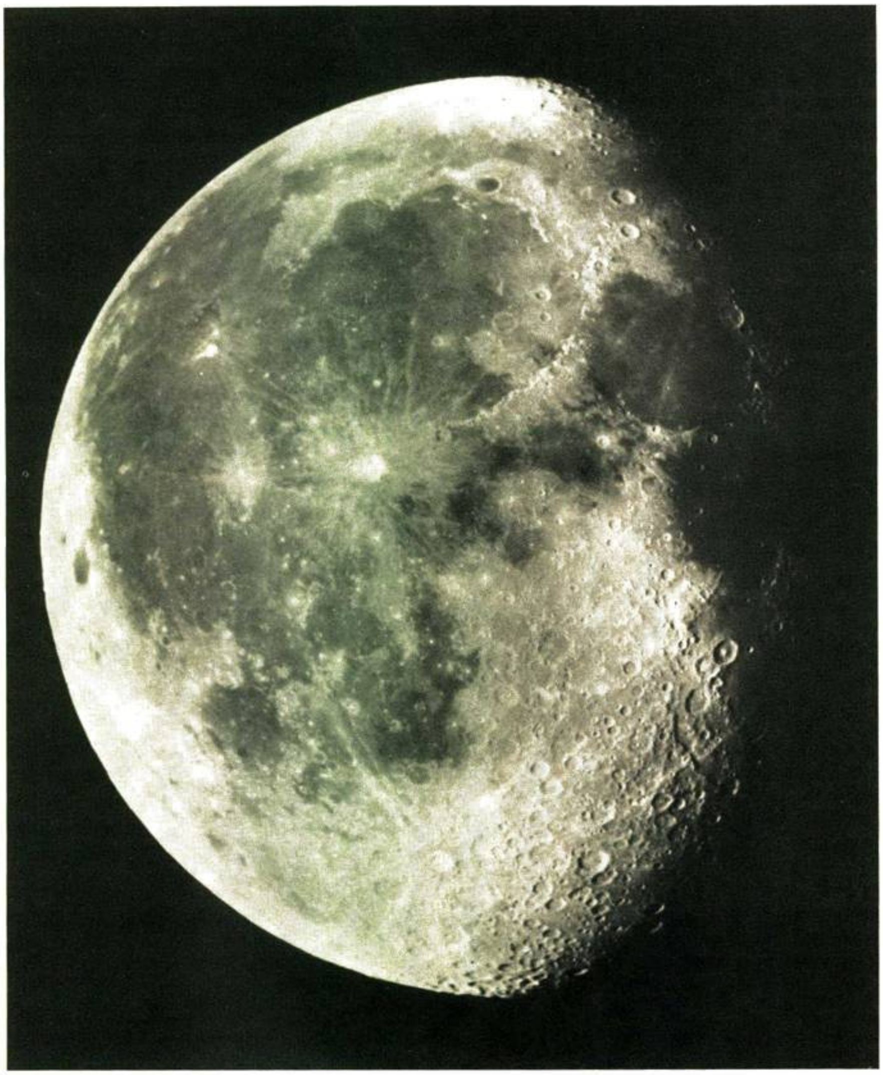
ASTRONOMY welcomes comments and additional information on articles and astronomy in general. Send your letters to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187. Letters may be edited for length or clarity.

THE ASTRONOMY OF PAUL REVERE'S RIDE

by Jacques Vialle and Darrel Hoff

On the eve of the American Revolution, Boston was a sleepy port city ringed by farming communities and held under British territorial control (as were the rest of the American colonies). Patriots in Boston felt especially uneasy in April 1775, because rumors were flying that the British would crack down hard and raid the colonists' supplies and munitions. The rumors proved true. Silversmith, printer, patriot, and able horseman Paul Revere took it upon himself to warn the people in the countryside of the impending disaster. But the British soon captured him.

Did the Moon play a role in Revere's dramatic performance and ultimate capture? According to Henry Wadsworth Longfellow's "The Midnight Ride of Paul Revere," it did. A local marker between Lexington and Concord that commemorates Revere's ride and capture yields additional clues about the Moon's role on that historic night. Now we can gain further insights into the night's events by recreating the sky with a modern computer program. Taken together, poetry, history, and science allow us to return in time to a night two hundred and seventeen years ago.



A BRIGHT GIBBOUS MOON shone down on the British troops and American patriots on the night of Paul Revere's famous ride. Photo by Jean Dragesco.

TWILIGHT
TOURS

GET MOONED
IN URUGUAY!!

Join Twilight Tours
on its 10 day tour to
Uruguay and Chile,
June 27 – July 6, 1992

Our expedition package includes:

- All Airfare to/from/in Latin America
- All ground transportation
- Daily breakfast
- VIP tour of ESO's La Silla Observatory
- Nighttime Observing Sessions

PRICE PER PERSON,
DBL. OCCUPANCY
$2300.00 - - - Ex Los Angeles
$2100.00 - - - Ex Miami
Call or write us today
for a Free Brochure:

Twilight Tours, Inc.
3316 W. Chandler Blvd.
Burbank, CA 91505
(818) 841-8245
FAX: (818) 843-6850

VISA We Gladly Accept MasterCard

A New Audio Cassette Series

The Constellation Companion™

An entertaining and fascinating
guide to each of the four seasons:

SPRING SKY ·
SUMMER SKY ·
FALL SKY ·
WINTER SKY ·

· LISTEN to the Legends
· LOCATE the Major Contellations
· LEARN the Stars names, sizes, and distances

It's like star gazing with
an astronomer !

$19.95 each plus $3.00 S/H or all
4 sets for $69.95 plus $5.00 S/H
(1 set / season = 2 casseettes and a booklet)

BRAZEN SKY PRODUCTIONS
1700 E. Elliot Road, #6, Suite 345
Tempe, Arizona 85284

Arizona residents add 6.5%. Allow 4 weeks for delivery.

Orion Exclusive — Special Edition!

Celestron f/10 & f/6.3 Ultima 8 PEC Package

High-Tech White Finish!

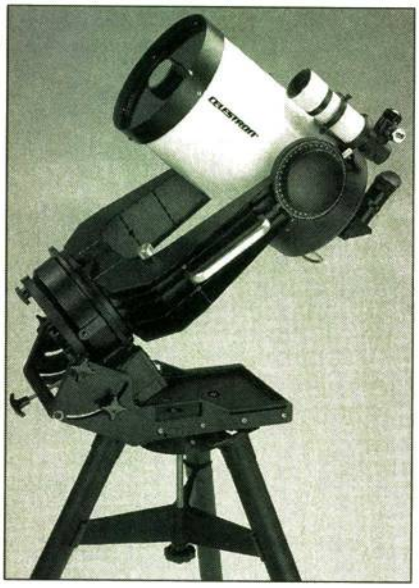
By special arrangement with Celestron International, Orion is offering the advanced Ultima 8 telescope with a new high-tech white finish and an expanded accessory package at a special price that is sure to appeal to the advanced amateur astronomer.

The Special Edition Celestron Ultima 8 PEC has all the features of the popular standard model, including the renowned Celestron 8" optical system with Starbright coatings and Byers drive system with electronic control system and Periodic Error Correction.

Special bonus accessories include:
- Celestron f/6.3 photo-visual Reducer/Corrector for wide-field performance ideal for astrophotography
- 35mm camera T-adapter
- Tele-extender for high power planetary photography
- 12.5mm (160x) Ultima eyepiece
- Electric declination motor drive
- Electric focus motor.

Of course, you get all the standard Ultima accessories, too:
- Improved adjustable field tripod
- Heavy duty equatorial wedge
- 30mm Plössl eyepiece (68x)
- 7mm Orthoscopic ocular (290x)
- Multi-coated 1.25" prism star diagonal
- Convertable 8x50 finder scope
- Push-button hand controller
- Setting circles
- Premium storage case

Plus, Orion is including a FREE Ultrascopic 3-element barlow lens, a $64.95 value!



This feature packed package is an incredible value! **Available for a limited time at a special package price *only* from Orion Telescope Center.**

Complete Package

#21090 **$2399** (55.92)

America's #1 Source for

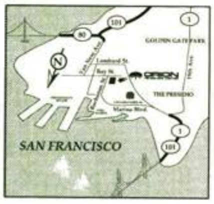
CELESTRON

Call or write for our **free 68 page catalog.** Packed with a huge selection of quality Celestron and other fine telescopes and accessories. The largest selection of telescopes, binoculars & accessories in the USA all at low discount prices!

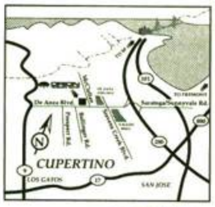
When You're in the San Francisco Bay Area, Visit One of Our Three Unique Retail Stores.

America's biggest & best selection of telescopes, binoculars & accessories. Now 3 convenient Northern California locations!

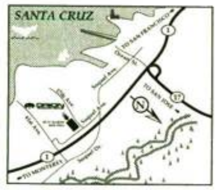
San Francisco
1 block from Marina Safeway
3609 Buchanan St., at Bay
415/931-9966



Silicon Valley/
San Jose/Cupertino
10555 S. DeAnza Blvd., at McClellan
From Hwy 280 take Cupertino exit, south 1.5 miles on DeAnza, from Los Gatos take Hwy 9 to Saratoga-Sunnyvale Rd.
408/255-8770



Monterey Bay/Santa Cruz
2450 17th Ave., West Marine Building,
From Hwy 1, take Soquel Drive exit,
1/2 block from the freeway
at Soquel Avenue
408/464-0465



MONEY BACK GUARANTEE

If you are not completely satisfied with your purchase from Orion, for any reason,

100% SATISFACTION

Just return it in new condition within 30 days after delivery for a full refund.

Orion® 7x50 & 10x50 Observer™ Binoculars

Fine quality, moderately priced binoculars, excellent for both astronomy and daytime observation. Fully coated optics, rugged ribbed rubber covering for a good grip. Both have a 7° field of view.

7x50 #9620.
NEW! *10x50* #9623. **$84.95** (4.44)

Orion® 7x50 & 10x50 Explorer™ Binoculars

Our newest high performance binoculars with BAK-4 prisms and Multi-Coatings. Great for both astronomy and daytime observation. Comfortable ergonomic body design.

7x50 #9306 **$109** (4.71)
10x50 #9308 **$114** (4.71)

Orion® 8x56 Mini Giants

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects, daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view. Standard model 33 oz. Rubber Armored for protection from bumps. Weighs 37 oz.

NEW! Rubber Armored Model #9627 **$149** (5.07)
Standard Model #9504 **$149** (4.71)

Superior Performance 7x50 Adlerblick Binoculars

Incredible wide field eyepiece design, Fully Multi-Coated, BAK-4 prisms, and best special glass objective lenses make the 7x50 Adlerblick the arch rival of European brand binoculars selling for 3-4 times the price. Orion buys direct, saving you money. Includes deluxe hard case, lens caps and straps.

#9612 **$279** (5.28)

Orion® 10x70 Fully Multi-Coated Enhanced Giants

The standard for hand-holdable astronomy binoculars. 33% lighter—weighs only 58 oz.—yet the same brightness and 7mm exit pupil as our 11x80 MC model. Superior 'BCF' body design. Includes: soft rubber eyecaps, tripod mounting adapter, durable hard carrying case, lens caps and straps.

#9501 **$299** (6.97)

Orion® 80mm Enhanced™ Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest field available. Ideal for deep-space observation under dark skies. Hand-holdable.

#9502 **$369** (8.05)

16x80 MC- 45% higher power, excellent for astronomy and daytime observation. Tripod recommended.

#9496 **$379** (8.05)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required.

#9498 **$389** (8.05)

SuperGiant™ 14x100

Gigantic, almost 4 inch, lenses gather 156% of the light of 80mm binoculars. Individual eyepiece focus, fully multi-coated optics and BAK-4 prisms. Comes with tripod mounting plate and metal-clad case. 14x magnification, field of view 3.3°, exit pupil 7.0mm, weight 7.5 lbs., height 13.5".

#9495
$849 (17.12)

Orion® 12.5mm Plössl Illuminated Reticle Eyepiece

This new 12.5mm 4-element Plössl offers unprecedented eye relief and observing comfort during long astrophoto exposures. The battery operated integral illuminator has fully adjustable brightness. Features double crossline reticle.

#8484 **$129** (3.45)

World's Finest Illuminated Reticle Eyepiece

6mm Orthoscopic design for required high power guiding, plus unique X-Y adjustable reticle positioning for easy guide star alignment. Wireless LED illuminator has adjustable brightness.

#8487 **$149** (3.67)

Orion® 9mm Orthoscopic Illuminated Reticle Eyepiece

9mm Orthoscopic eyepiece with wireless adjustable brightness illuminator. Bull's-eye within three concentric circles helps measure limits of acceptable guiding error.

#8488 **$119** (3.67)

Orion® 12mm Kellner Illuminated Reticle Eyepiece

12mm Kellner eyepiece with cable plugs into LX/3, LX/5 and Premier drive bases, and most drive correctors with illuminated reticle output for polar alignment and guiding.

#8482 **$74.95** (3.45)

Orion® VariPower™ 2-3x Multi-Coated Barlow Lens

Our best barlow fills the gaps in your eyepiece collection. Internal lens cell slides easily to adjust magnification. Quality optics provide excellent sharpness, contrast and brightness. Works with 1.25" diameter eyepieces and right-angle diagonals.

#8748 **$69.95** (3.45)

Orion® 3-Element Fully Multi-Coated Barlow Lens

Fully Multi-Coated 3-Element Barlow lens provides superior imaging with precise color correction at three wavelengths. For maximum light transmission and highest contrast, we have used the finest quality multi-coating on each air to glass surface. 1.25" diameter.

#8750 **$64.95** (3.45)

Orion® Deluxe Fully-Baffled Multi-Coated Barlow Lens

Fully internally opaqued and baffled to block stray light for noticeably higher contrast. Large 27mm multi-coated 2-element lens provides 2x magnification with any 1.25" eyepiece.

#8746 **$49.95** (2.98)

Orion® Big Eye™ 8x50 & 11x80 Finder Scopes

You might spend more time viewing through the finder than through your main telescope! Big Eye Scope is Ideal for upgrading any telescope including Schmidt-Cassegrains. Available non-illuminated or with wireless, adjustable, battery-operated illuminated reticle and Polaris grid for accurate polar alignment. With 90° diagonal prisms. Optional deluxe dual-ring brackets are perfect for 8" and 10" Celestron or Meade; will fit many others, too.

8x50 Models The 50mm objectives gather 2.7 times more light than 30mm finders!

8x50 Standard Finder #7100 **$89.95** (3.95)
8x50 Illuminated Finder #7135 **$129** (4.19)
Bracket— For 50 mm #5143 **$37.95** (2.98)

11x80 Models These huge finders gulp in over 7 times the light of 30mm finders; 2.5 times more than 50mm models!

11x80 Standard Finder#7146 **$199** (4.71)
11x80 Illuminated Finder #7143 **$269** (5.28)
Bracket— For 80 mm #5140 **$53.95** (2.98)

ORION
TELESCOPE CENTER

CALL TOLL-FREE
800-447-1001
IN CALIFORNIA: 800-443-1001

Offices
408-464-0446

77° Field UltraScan™ Wide Angle Eyepieces

Fantastic panoramic eyepieces, up to 77° fields. Rival 'famous' brands at a fraction of the price! Superb coatings and optics.

1.25" UltraScan Eyepieces

9mm-#8420 **$99** (3.45)
12mm-#8421 **$109** (3.67)
15mm-#8422 **$129** (3.67)
19mm-#8423 **$139** (3.67)

30mm 2" UltraScan Eyepiece

#8424 **$219** (4.71)

40mm 2" UltraScan Eyepiece

Orion's brightest, widest true-field UltraScan eyepiece utilizes a sophisticated 7-element design, providing a 68 degree apparent field, the widest we could fit into the 2" diameter barrel.

#8425 **$199** (3.67)

High Resolution Orion® Ultrascopic™ Eyepieces

Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7- element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Compare with other brands selling for much more!

Wide Field 5-element

35mm #8560 **$99.95** (3.45)
30mm #8562 **$89.95** (3.45)
25mm #8564 **$74.95** (3.45)

Medium-High Power 5-element

20mm #8566, 15mm #8568, 10mm #8570, 7.5mm #8572

$69.95 ea. (3.45)

High Power 7-element 5mm #8574, 3.8mm #8576

$89.95 ea. (3.45)

Orion® MegaVista™ 1.25" Wide Angle Eyepieces

Incredible Fully Multi-Coated high-transmission 7-element eyepieces with integral rubber eyeguard and long eye relief.

10.5mm—An incredible 67° field for outstanding planetary or deep space performance.

#8552 **$119** (3.67)

16.8mm—Outstanding high-contrast eyepiece with stunning 70° field ideal for deep space.

#8554 **$119** (3.67)

Orion® UltraZoom™ 7-21mm 1.25" Eyepiece

The finest zoom you can buy for your 1.25" telescope. An excellent choice for astronomy or terrestrial observing. 65°-35° field.

#8556 **$139** (3.67)

Orion Plössl Eyepieces!

Orion Multi-Coated Plössl eyepieces are fine performers at an amazingly low price. Precision 4-element Plössl lens elements mounted in sturdy aluminum barrels. Available in 12mm, 18mm, or 25mm focal lengths, with 1.25" barrels. Buy all three for less than some single eyepieces!

12mm-#8596; 18mm-#8597; 25mm-#8598 **$44.95** *ea.* (2.98)

Orion® Explorer Series 1.25" Eyepieces

Remarkably affordable, Multi-Coated parfocal eyepieces with great performance. Each carefully selected series has been chosen to provide a sensible progression of magnifications. Threaded for filters. Internally blackened to prevent stray light reflections.

Kellner Eyepieces-
6mm #8536, 9mm #8538, 12mm #8540, 18mm #8508, 25mm #8510, 40mm #8512

$38.95 ea. (2.98)

Orthoscopic Eyepieces-5mm #8500, 7mm #8502, 9mm #8504, 12.5mm #8506, 18mm #8524, 25mm #8526

$49.95 ea. (2.98)

Orion® Explorer Series .965" Eyepieces

Get the most from your small telescope with these fine Multi-Coated eyepieces. Standard .965" barrels fit all Japanese standard small telescopes.

.965" Orthoscopic Eyepieces-
5mm #8580, 7mm #8581
9mm #8582, 12.5mm #8583

$46.95 ea. (2.98)

.965" Kellner Eyepieces
18mm #8584, 25mm #8585
.965" Achromatic Huygenian Eyepieces- 40mm #8586

$33.95 ea. (2.98)

Orion® SkyGlow™ Enhanced Light Pollution Filters

Enhance your viewing of faint deep sky objects with the best broadband light pollution filter you can buy. Our SkyGlow absorbs frequencies emitted by city lights, allowing transmission of the rest of the visible spectrum, yielding dramatic results.

SkyGlow Broadband Filters-Photographic and Visual
For use in slight to moderately light polluted areas.

1.25" Broadband Filter–fits 1.25" eyepieces.
#5660 **$69.95** (3.45)

Schmidt-Cassegrain Broadband Filter–fits rear cell of Meade & Celestron SC scopes.
#5658 **$89.95** (3.45)

52mm Broadband Filter–For 52mm camera lenses, adapter rings available for other diameters.
#5668 **$89.95** (3.45)

SkyGlow UltraBlock Filters-Visual Only
For severely light polluted areas and faint nebulae.

1.25" UltraBlock Filter–fits 1.25" eyepieces.
#5654 **$99.50** (3.45)

Schmidt-Cassegrain UltraBlock Filter–fits rear cell of Meade & Celestron SC scopes.
#5656 **$139** (3.67)

Orion® Color Filters for Eyepieces

Solar system observations are dramatically improved by Orion colored filters. For visual use, thread one into the barrel of any standard eyepiece. For planetary and lunar photography, Schmidt-Cassegrain owners can attach the filter to the eyepiece inside the tele-extender. Can also be threaded directly into a universal camera adapter.

Basic Set of 4 Filters .965"- Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5510 **$34.95** (2.98)

Basic Set of 4 Filters 1.25"- Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5514 **$44.95** (2.98)

Expansion Set of 4 Filters 1.25"- Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.
#5516 **$44.95** (2.98)

Advanced Set of 4 Filters 1.25"- Includes #8 Light Yellow, #23A Light Red, #38A Deep Blue, #56 Light Green.
#5570 **$44.95** (2.98)

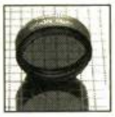
Full Set of 12 Filters for 1.25"- Includes Basic Set, Expansion Set, Advanced Set.
#5575 **$119** (3.67)

Deluxe Set of 8 Filters 1.25"- Includes all the filters in our basic and expansion filter sets.
#5517 **$84.95** (3.45)

Individual 1.25" Filters- #80A Blue (#11040), #58 Green (#5540), #25 Red (#5536), #15 Yellow (#5532), #21 Orange (#5534), #47 Violet (#5538), #11 Light Yellow-Green (#5530), #82A Very Pale Blue (#5544), #8 Yellow (#5571), #23A Light Red (#5272), #38A Deep Blue (#5273), #56 Light Green (#5274)

$13.95 ea. (2.43)

Moon Filters



Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.

.965" #5664 **$14.95** (2.43)
1.25" #5662 **$14.95** (2.43)

Deluxe Eyepiece Case

Organize and protect your valuable eyepieces and other accessories. This durable case with double hinges holds up to 10 eyepieces plus barlow. Die cut foam insert for snug secure fit. O.D. 8-1/2"x12-1/2"x3-1/8".

#5913 **$17.95** (2.78)

Deluxe Metal-Clad Accessory Cases

Keep accessories and camera safe and clean. Diced foam inserts can be tailored to your needs. Sturdy handle, two latches, key.

Regular Case: 16"x12"x6½"
#5920 **$59.95** (6.67)

Large Case: 19½"x12"x6½" #5921 **$69.95** (7.10)

Deluxe Field Tripod Tote Bag

Designed for the field tripod with padded insert to separate wedge from tripod during transportation. Specifically made for wedge combinations of Schmidt-Cassegrain telescopes up to 10" aperture. Allows storage without changing polar alignment. This blue bag is made of tear, rip and mildew resistant 100% Cordura nylon.

#15096 **$79.95** (5.19)

Orion® FlexiShield™ Dew Caps

Eliminate dew problems with FlexiShield! Better performance, more rugged, and easier storage than rigid dew caps. Forms into a tube with the velcro closure, opens flat for easy storage and transportation. Fits your telescope tube snugly, with wide rubber padding and full length velcro closure—needs no screws. Models to fit most telescopes.

90mm Celestron/Meade Spotting Scopes	#4203	**$24.95** (2.78)
90mm Celestron Rubber Armored Spotting Scopes	#4205	**$24.95** (2.78)
4" Meade Schmidt-Cassegrain	#4204	**$24.95** (2.78)
8" Celestron/Meade Schmidt-Cassegrains	#4200	**$39.95** (2.98)
10" Meade Schmidt-Cassegrains	#4201	**$49.95** (2.98)
11" Celestron Schmidt-Cassegrains	#4202	**$59.95** (3.95)

Orion® Dew Zapper

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature slightly above air temperature.

8" Dew Zappers-fit all Meade & Celestron 8" Schmidt-Cassegrains
DC Model #3503, AC Model #3504 **$44.95** (2.98)

10" Dew Zappers- fit all Meade 10" Schmidt-Cassegrains
DC Model #3506, AC Model #3508 **$49.95** (2.98)

Dew Remover Gun

Moisture that interferes with viewing dissipates quickly with this 12V DC, 156 watt warm air gun. Has 4-1/2' cord.

#5601 **$17.95** (2.78)

Orion® Slow Motion Adapter

Attaches to your tripod pan head and gives you two slow motion control knobs to make precision adjustments in altitude and altazimuth. Very handy for tracking planets, the Moon, etc. with refractor telescopes and small spotting scopes. Attaches to any camera tripod with a standard 1/4-20 thread.

#7012 **$49.95** (2.98)

Orion® Dual Balance System

Unlike ordinary counterweights, our system allows instant adjustment in both directions. Easily balances your scope to offset both piggyback loads or rear cell cameras, 2" diagonals, and other accessories. Rigid, precision machined dovetail bar mounts to telescope in existing accessory holes.

For Meade SC 8"	#5150	**$79.95** (4.78)
For Celestron 8" C-8	#5149	**$74.95** (4.78)
For Meade SC 10"	#5152	**$84.95** (4.78)

Starlite Red LED Flashlight

The Starlite is the only adjustable-brightness night-vision red flashlight. Lifetime solid-state LED can't burn out. Extra efficient electronic circuit for long battery life. Uses one 9-volt battery (not included).

#5714 **$24.95** (2.43)

Astronomer's Flashlight

Indispensable and indestructible. Has special night-vision red filter and a diffusion lens for even illumination. An essential addition to your astronomy accessories. Requires 2 D-cell batteries (not included).

#5701 **$9.95** (1.79)

Rechargeable Battery Porta Pac

12 Amp Hour Porta Pac
Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper. Battery is encased in high impact polystyrene. Carrying case of Cordura nylon with shoulder strap and handle. Wt. 10 lbs.

#2354 **$109 ea.** (8.97)

Popular Observer's Chairs

Make observing more comfortable and enjoyable with one of these great chairs.

Standard Model—
Has adjustable height center column and padded vinyl seat. Folds for easy storage.
#5935 **$39.95** (4.70)

Deluxe Model—
Is much heavier-duty, built for professional musicians. Extra thick padding, wide footprint. Adjustable and disassembles for storage.
#5934 **$89.95** (8.02)

Orion® UltraGuider™

Advanced features most requested by advanced deep space astrophotographers at a low price. Use with your Meade or Celestron Schmidt-Cassegrain telescope. Easily adjustable prism allows wider choice of guide stars. Ultra-precise helical focus of your eyepiece, adjustable camera focal plane position.

#5139 **$119** (4.19)

Orion® Premium Off-Axis Guider

Multi-Coated for Peak Performance! Low Orion price for our popular, precision anodized guider.

#5144 **$59.95** (3.45)

Rack & Pinion Focusers

These top quality focusers are designed for Newtonian reflectors. Fit any size tubes.

1.25" Focuser
Quality diagonal-cut rack for smooth focusing. Secure slide-fit eyepiece holder. Integral socket for single-stalk diagonal support if desired.

#13017 **$49.95** (2.98)

2" & 1.25" Focuser
Large clear diameter ideal for larger scopes and wide field optics. Precision diagonal cut rack. Long travel for visual and photographic use. Interchangeable 2" and 1.25" holders with set screws.

#13019 **$89.95** (3.95)

Orion® 45-Degree Erect Image Diagonals

See the world as it really is with Orion's new 45-degree erect image diagonal. Upside-down, backwards and topsy-turvy images can often confuse even the stoutest and most experienced observer. Turn it right-side-up with your choice of three models to select from.

.965 Diagonal	#8759	**$69.95** (3.45)
1-1/4" Diagonal	#8753	**$69.95** (3.45)
Size-Adapting Hybrid Diagonal	#8755	**$69.95** (3.45)

Star Diagonals

1.25" Star Diagonal
Primarily for astronomical use, lets you view at a right angle. Multi-Coated, for 1.25" eyepieces.

#8763 **$39.95** (2.98)

.965" Star Diagonal
Same as 1.25" Star Diagonal, but with standard coated optics. Works with .965" eyepieces and eyepiece holders.

#8761 **$24.95** (2.98)

2" Star Diagonal

Get the widest possible field of view from your Schmidt-Cassegrain Telescope. This star diagonal features a special aluminized and overcoated precision first-surface flat mirror.

#8767 **$99.95** (3.45)

Orion® Tele-Extenders

For high powered photography with your Meade, Celestron 4", 8", 10", 11", 14" Schmidt-Cassegrain.

Standard Tele-Extender
Use this Tele-Extender in conjunction with an eyepiece. Attaches to visual back of Meade or Celestron Schmidt-Cassegrain telescopes, and to 35mm camera with T-ring, sold separately.

#5125 **$27.95** (2.98)

Variable Tele-Extender
Uses an adjustable extension tube, allowing magnification to be changed without switching eyepieces. Attaches with T-ring, sold separately.

#5127 **$39.95** (2.98)

Universal Camera Adapters

Standard Universal Camera Adapters
Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders Use with T-Ring (sold separately) to match your 35mm camera.

.965" #5268 **$29.95** (2.98)
1.25" #5264 **$34.95** (2.98)

Variable Power Camera Adapter

Unique sliding barrel design allows variable projection distances during eyepiece projection photography, eliminating the need to change eyepieces when magnification changes are required.

#5262 **$44.95** (2.98)

Orion® T-Adapter

For prime focus photography. Use with T-ring to match your 35mm camera. For Meade, Celestron 4", 8", 10", 11", 14" SC. Can be used as 2" camera adapter.

#5116 **$27.95** (2.98)

MasterCard

VISA

IT'S EASY TO ORDER

- Call Toll-Free and charge to your MasterCard or Visa or send your personal check to order by mail.
- California residents add 7.25% sales tax (8.25% in San Francisco, Santa Clara and Santa Cruz Counties).
- Shipping & handling charge for UPS Ground or US Mail to lower 48 United States are listed in (parentheses) after each price.
- We ship to U.S. and Canada only.
- Prices are normally good through end of magazine issue month, but are subject to change or correction.

ORION
TELESCOPE CENTER
2450 17th Ave., P.O. Box 1158-A
Santa Cruz, CA 95061

When ordering, mention key code FMA

Same-Day Shipping
***plus* Courteous Service!**

Authorized
APD
Dealer!

CALL SHUTAN!
Meade's Only Authorized
Upper-Midwest
APD Mail-Order Dealer!

Accy case 50	$69	Nebula 911N	$110
Filter set of 4	43	Off-axis syst	169
Filter set of 8	83	Piggy brkt 8"	33
Filter set of 12	119	Piggy brkt 10"	33
Illum 12mm	65	Sky/dust seal	45
Illum 12mm-wless	90	Star diagonal 2"	90
Illum 9mm	95	Tele extender	27
Illum 9mm-wless	119	T-adapt-std	27
Lenshood 8"	59	T-adapt-vari	40
Lenshood 10"	124	T-mt.-non AF	14
Nebula 908B	68	T-mt.-AF	19
Nebula 910B	99	Vari pol 905	45
Nebula 911B	88	Weight set 8"	84
Nebula 908N	90	Weight set 10"	89
Nebula 910N	119	WFAS	11

LX100/200	ED Refractor	Starfinder
8" f:10 or 6.3 10" f:10 or 6.3	4", 5", 6" and 7"	6", 8", 10" and 16"

New APD 4000 Eyepieces
Now with Collapsible Eyecups!

Ultra Wide		**Super Plossl**	
4.7mm	$134	Up to 26mm	$69
6.7mm	159	32/40mm	99
8.8mm	199	56mm	189
14mm	239	**Super Wide**	
Series II Ortho		13.8mm	119
4/6/9/12.5mm	48	18mm	129
Barlows		24.5mm	139
122 1-1/4" 2x	45	32mm	209
140 1-1/4" 2x	69	40mm	279

Call Toll-Free Today!

Celestron:
- Ultima-8 PEC
- Ultima-11 PEC
- Classic-8
- C90's

*Call for **SHUTAN'S** Discount Prices!*

Solar Filters in Stock!
Highest quality 1000 Oaks • Type II glass!
4" **$72** 8" **$119** 10" **$129** 11" **$149**

MotoFocus & MotoDec

Electric DEC with variable speed!	**Electric Focus with variable speed!**
To fit LX3/5/6 .... **$85**	To fit LX2/3/5/6 **$92**

Konica ASA 3200
Color Print Film
Assures shortest possible exposure without having to Hyper!
Five (5) 24exp. rolls for $34

TeleVue:
- Genesis
- Pronto
- Renaissance
- Mounts/tripods

*Call for **SHUTAN'S** Discount Prices!*

Naglers:		**Wide Field:**	
4.8mm	$149	15mm	134
7mm	179	19mm	139
9mm	219	24mm	164
12mm Type2	254	32mm	234
16mm Type2	284	40mm	299
20mm Type2	349	**Panoptic:**	
Plossl:		22mm	254
Up to 26mm	$79	35mm	329
32/40mm	99	Bar. interface	89
55mm	210	**Barlows-1.25":**	
Big Barlow 2"	184	2.5x or 1.8x	79

Mention this ad for *FREE* shipping*

SHUTAN camera & video

Our 74th Year Providing The Finest Service!
Please send $1 for first-class mailing of our 64-PAGE Discount Buying Guide! Products include full factory packaging. Call for current price info— ad is placed 60+ days prior to publication! We don't charge extra when you use your charge card! *Most accy. orders over $100 include FREE UPS shipping in continental U.S. if *THIS AD* is mentioned.
Visa, Mastercard, Amex, Check, Cash C.O.D.

SHUTAN
camera & video

312 W. Randolph • Chicago • 60606
M-F 8:30-5:30 • Saturday 9-5
Call Toll-Free!
☎ **800-621-2248**
Illinois 312-332-2000

To set the stage for the night's events, let's look at the strategy of the British and what that strategy has to do with Longfellow's memorable line "one, if by land, and two, if by sea." The colonists had hidden a cache of supplies in a small barn in a little town called Concord. At the time, the British troops occupying Boston under the command of General Thomas Gage were somewhat restricted in their movements. Boston then was connected to the mainland by a small neck of land. (The inlet in that neck, Back Bay, has long since been filled in and buildings constructed on the filled area.) During revolutionary days, only two routes connected Boston with the mainland, either by road along the neck ("by land") or across the Charles River estuary ("by sea").

The British probably considered the raid on Concord to be a routine operation. General Gage and his staff merely had to choose the route and the time. Moving by the land route to Concord meant a longer march (about four extra miles, which would take an extra hour). Moving by sea required a delicate amphibious operation: ferrying about 700 troops across a tidal river was indeed no easy task. Because secrecy was essential, it would have to be done at night.

Revere apparently suspected the British would choose the route by sea. On Sunday, April 16, he observed that smallboats were launched from *H. M. S. Somerset*, a British man-of-war moored in the Charles River. Although uncertain about the route, Revere logically presumed that Gage's infantry would set off at night, and he made arrangements accordingly with his friend, Colonel Conant, and other gentlemen. If the British went by water, Revere later wrote, "We should shew two lanthorns in the North Church steeple, and if by land, one as a signal, for we were apprehensive it would be difficult to cross the Charles River, or to git over Boston neck."

At about 10:00 p.m. on the evening of the 18th, Dr. Joseph Warren, a patriot and well-known citizen, heard that the British troops were leaving their barracks, so he sent for Revere and William Dawes, Jr. Dawes was to ride to Lexington over the Boston neck while Revere would go over the shorter route through Charlestown. At about 10:30 p.m., two friends ferried Revere across the Charles a little east of where the *Somerset* lay.

Dawes, who had ridden the longer route, eventually caught up with Revere. The two were then joined by Dr. Samuel Prescott, a rider who was returning to his Concord home from Lexington. About 1.3 miles west of Lexington, two British officers surprised the group. Luckily for them, Dawes and Prescott were riding about 200 yards behind Revere and they escaped. But Revere was not so lucky. As he tried to bolt his horse toward a wooded area, he was confronted by six British soldiers who grabbed his bridle, aimed pistols at his chest, and forced him to dismount.

Unfortunately for the British, the raid was going poorly. At Lechmere Point in Cambridge, many disgruntled King's soldiers were waiting for provisions to be secured and divided. What should have been a surprise raid was doomed from the start, because Dawes and Prescott's warning gave the patriots ample time to get ready for the confrontation. Before the day was over, 73 British were killed, 174 wounded, and 26 missing — a casualty rate of 16 percent of the 1,700 deployed. The casualties were considerably smaller for the estimated 3,500 colonial militia troops who took part in the fighting.

Now, what role did the Moon play on that fateful night and how precise was Longfellow in his telling of the story? According to the Voyager computer program, the Moon was Full three days before Revere's ride. This meant that a bright, gibbous Moon would be shining down on the action below. The British troops would not have to march in pitch darkness, but neither would they or Revere have the cover of complete darkness.

As Revere and his friends made their way across the Charles River at about 10:30 p.m., they must have known that they would pass close to the *Somerset* for they muffled their oarlocks (with a petticoat, history tells us). As we read in Longfellow's poetic account of Revere's exploits,

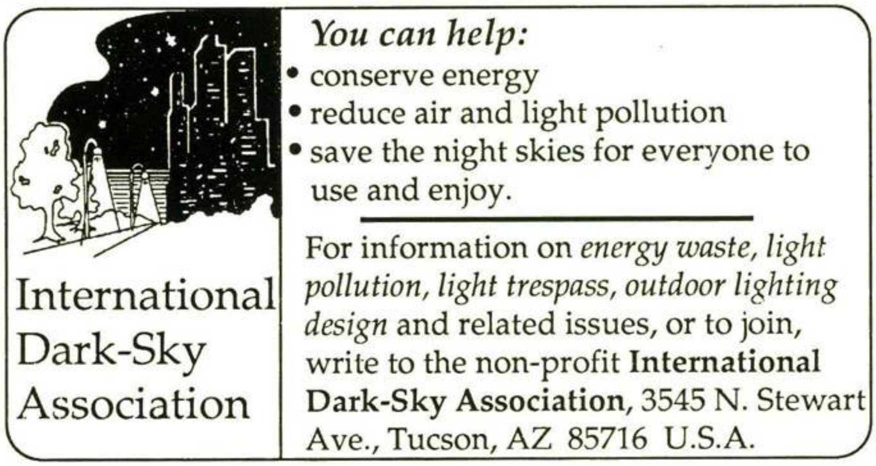
> Then he said, "Good night!" and with muffled oar
> Silently rowed to the Charlestown shore,
> Just as the moon rose over the bay.

Does Longfellow's poem accurately reflect the skies over Boston at this juncture? A skyplot made with the Voyager program shows that on April 18 the Moon rose in Boston at 9:36 p.m. local time. (Throughout this article, we shall assume that Boston local time is the same as Eastern Standard Time.) Longfellow was right on the

ASTRONOMY BOOKS

ASTRONOMY seeks manuscripts, book proposals, and software from writers in the astronomy book market. We plan to actively expand our book line over the coming months and therefore are interested in a wide range of astronomy projects focusing on both amateur astronomy and astronomical science.

Please send all pertinent materials to David J. Eicher, Book Editor, ASTRONOMY magazine, Kalmbach Publishing Co., 21027 Crossroads Circle, Waukesha, WI 53187. To ensure return of your materials, please enclose a large SASE with sufficient return postage. Send for our free brochure on how to submit your book proposal.



You can help:
- conserve energy
- reduce air and light pollution
- save the night skies for everyone to use and enjoy.

International Dark-Sky Association

For information on *energy waste, light pollution, light trespass, outdoor lighting design* and related issues, or to join, write to the non-profit **International Dark-Sky Association,** 3545 N. Stewart Ave., Tucson, AZ 85716 U.S.A.

The best way to a man's stomach...NordicTrack®.

Besides burning calories, it strengthens the heart, tones the muscles and improves stamina. And it's much less stressful on the body than running and high-impact sports. Working out on NordicTrack also boosts creativity and productivity and lowers stress, making you feel as good as you look.

It's time to change your spare tire.

Unlike most in-home exercisers, NordicTrack works all the major muscle groups of the body including the arms, legs, buttocks, shoulders and, yes, even stomach.

So what are you waiting for? Call NordicTrack today.

Call today for a 30 day in-home trial.

"The World's Best Aerobic Exerciser."™

NordicTrack duplicates the motion of cross-country skiing, which most experts agree is the most efficient and effective aerobic exercise.

It burns more calories in less time than many other exercise machines. Up to 1,100 calories per hour, according to fitness experts.

NordicTrack
A CML Company

Call or write for a **FREE VIDEO** & Brochure

1-800-328-5888 EXT. 524D2

Or write: NordicTrack, Dept. #524D2,
141C Jonathan Blvd. N., Chaska, MN 55318

© 1992 NordicTrack, Inc., A CML Company, All rights reserved.

★★★ NEW MAGAZINE! ★★★
Observatory Techniques
about astronomy & computer techniques!
Electronic Astrophotography, Computer Image Processing, Hints & Techniques, Programs for Astronomy, Astrocomputer Time Travel Astronomer's Vision and More!
Subscription $16 per year, 4 issues. Canada/Mexico $18.50 , Overseas $20 /airmail $24. Cash, check or money order in U.S. funds payable to Mike Otis, 1710 SE 16th Ave, Aberdeen, SD 57401

METEORITES
BUY-SELL-TRADE
Research and Museum Specimens
Private Collectors
Please send $2.00 for current listing
Seeside Engineering
P.O. Box 26391 San Diego, CA 92126
Fax (619) 695-8448

ECLIPSE DATA
FOR OCCURANCES FROM
MARCH 7, 1951 TO MAY 9, 2032
MAP OF CENTRAL LINE & LIMITS
SPECIFY WHICH ECLIPSE $1
DATA POINTS IN INTERVALS OF 1
5 OR 10 MINUTES. LISTING
LONG & LAT DURATION WIDTH & MORE
OF THE CENTRAL LINE OF CHOSEN
ECLIPSE 1 MINUTE INTERVALS $3
5 MINUTE INTERVALS $2
10 MINUTE INTERVALS $1
SAMPLE A LIST OF THE 180
ECLIPSES BETWEEN
THE ABOVE DATES PLUS A DATA
LIST (10 MIN INT) AND MAP
OF THE JULY 11 1991 EVENT
SAMPLE PACK $2
ADD $1 PER ORDER
FOR P&H
DAN
SONYE
BOX 217
LORAIN OH
44052-0217

DOB DRIVER $395

Now any Dobsonian can track the stars with this 2-axis digital pan/track/correct system!

- Dual industrial instrument STEPPER drives with all adapting & mounting hardware included at no extra cost! - Ready to go!
- Super portable, only a few pounds, instant setup with NO ALIGNMENT AT ALL!
- Tracks at any rate desired, 10-turn industrial controls for fine tune.
- High speed push-button panning for scope pointing, object seek, sweeps. Fine pan mode for rate correction, object touring.
- Adaptable to non-Dob mounts, equatorials.
- Runs on AC/DC/CAR/BAT.

You'll find yourself cruising across lunar terrain at high powers, leisurely inspecting the hearts of galaxies, nebulae & clusters, sketching or guiding photos, and sharing these experiences with others - while DOB DRIVER follows your target!
Place orders early.
TECH2000
3349 S.R. 99 S.
Monroeville, OH 44847
(419) 465-2997
10-Day Inspect • Free Literature

money. The moonlight undoubtedly made it easier for the troops to negotiate the countryside. It also made it easier for the thin screen of horsemen that General Gage had laid out all the way to Concord to spot any suspicious movements.

The marker tells a slightly different story than either Longfellow or Voyager, however. According to it, Revere was captured by the British "about two o'clock of the morning of April 19, 1775, the night being clear and the Moon in its third quarter." Based on the distance of Revere's travel, this time seems reasonable, but the Moon's phase is at best an approximation.

Using Jean Meeus' *Astronomical Formulae for Calculators,* it's easy to find that the Moon's phase was 0.87 on April 18, 1775, at midnight local time (April 19 at about 5h universal time). Voyager confirmed that when Revere was halted by the British, the Moon was fairly high in the sky, on the way to its transit at 2:42 a.m. and shining at magnitude –12.8, thus providing ample light.

A perpetual calendar tells us that the Moon was 18 days old on that famous evening. This modern analysis raises a slight problem, as the marker commemorating the arrest clearly describes a Moon at "third quarter." But an 18-day-old, 87-percent-lit Moon appears significantly different than a Third Quarter Moon. Perhaps the people who wrote the marker description used "third quarter" as a broad term to signify a Moon well past Full but not yet a crescent.

Are there any other references to the Moon's phase on this historic night? There is in Longfellow's image of the *Somerset* lying at her mooring in the Charles River:

A phantom ship, with each mast and spar,
Across the moon like a prison bar,
And a huge black hull, that was magnified
By its own reflection in the tide.

This suggests a bright Moon — full or gibbous but certainly not third quarter — although the detail is the poet's invention since Revere passed east of the ship. (Incidentally, had Revere observed the ship, he would have seen it from a distance of several hundred yards — not enough to see a "huge black hull magnified by its own reflection.")

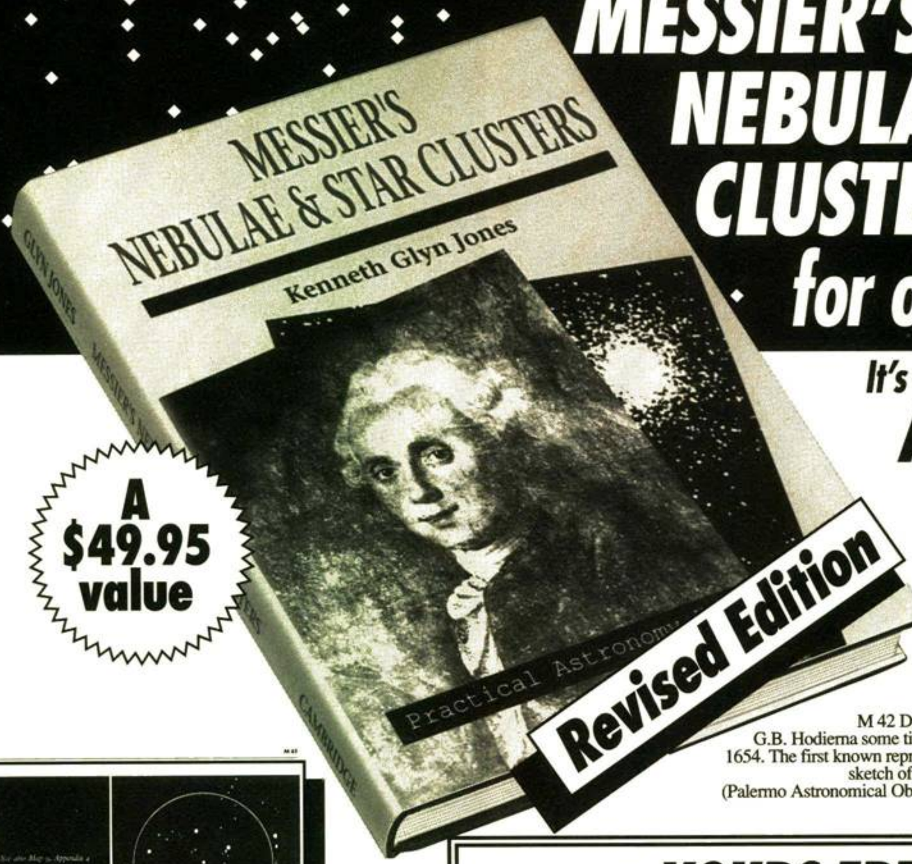
Longfellow's image of the ship "swinging wide at her moorings" is no romantic fancy, however. A computer program made available to merchant seamen by the French *Service Hydrographique et Oceanographique de la Marine* confirms that on the evening of April 18, high tide did occur in the Bay of Boston shortly before midnight. The British grenadiers and light infantry started embarking on the Back Bay from Boston Common at about 10:30 p.m., with the rising tide. The smallboats and barges were heavily loaded. For that reason, they could not be run in close to land and the troops had to wade ashore. We can safely assume that the tidal height would have determined how close to shore the boats could come.

Whether the height of the tide directly influenced the time the troops crossed or landed is not clear. It's impossible to determine by examining the area today how low the tidal basin would have been at the time of landing. The Moon was at perigee about 4 days later, which supposes a fairly wide amplitude for the tide of April 18. In those days, however, predicting tidal height on a definite day was mainly guesswork. Though General Gage certainly would have known ahead of time when high tide would occur, it's unlikely he had anything better than a hazy picture of the evolution of the local tides and how high they would be.

We commonly remake history. Had it been darker and had the tide been more favorable that night, the face of the world might have changed. Recreating the astronomical conditions on that famous night allows us to make a fascinating journey into our country's past. Assessing the real importance of these conditions on the unrolling tide of the events is quite another story.

Suppose we took the matter differently and date the event from the astronomical data found in Longfellow's poem? Then Paul Revere's ride took place a few days after the Full Moon — to account for its rising in mid-evening and being bright enough so the ship's reflection could be seen — at most a day or two before the actual date. If, on the other hand, we accept the evidence for the Moon's phase from the marker, then the patriot set off on his midnight ride three or four days after the actual date. This shows how cautious we must be when dating events from astronomical details found in literary or archaeological sources. Paul Revere's ride is a nice example of how art and science can complement each other to give us a deeper and more rewarding picture of important historical events. Alone, they tell us only part of the story. ☐

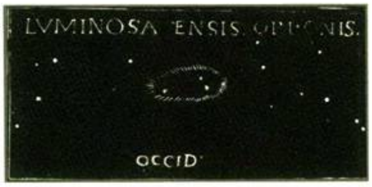
MESSIER'S NEBULAE & STAR CLUSTERS for only $1.00



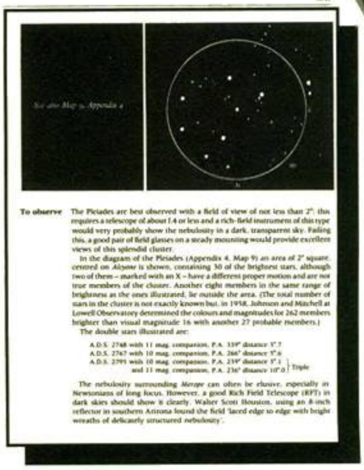
A $49.95 value

It's your no-risk introduction to the
Astronomy Book Club

You simply agree to buy three more books — at significant savings — within the next 12 months.



M 42 Drawing by G.B. Hodierna some time before 1654. The first known representative sketch of a Nebula. (Palermo Astronomical Observatory)


M 42
See also Map 9, Appendix 4

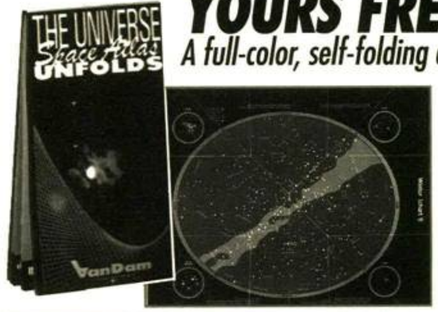
To observe The Pleiades are best observed with a field of view of not less than 2°: this requires a telescope of about f/4 or less and a rich-field instrument of this type would very probably show the nebulosity in a dark, transparent sky. Failing this, a good pair of field glasses on a steady mounting would provide excellent views of this splendid cluster.

In the diagram of the Pleiades (Appendix 4, Map 9) an area of 2° square, centred on *Alcyone* is shown, containing 30 of the brightest stars, although two of them – marked with an X – have a different proper motion and are not true members of the cluster. Another eight members in the same range of brightness as the ones illustrated, lie outside the area. (The total number of stars in the cluster is not exactly known but, in 1958, Johnson and Mitchell at Lowell Observatory determined the colours and magnitudes for 262 members brighter than visual magnitude 16 with another 27 probable members.)

The double stars illustrated are:

A.D.S. 2748 with 11 mag. companion, P.A. 339° distance 5″.7
A.D.S. 2767 with 10 mag. companion, P.A. 266° distance 5″.6
A.D.S. 2795 with 10 mag. companion, P.A. 239° distance 5″.1 } Triple
and 11 mag. companion, P.A. 236° distance 10″.0

The nebulosity surrounding *Merope* can often be elusive, especially in Newtonians of long focus. However, a good Rich Field Telescope (RFT) in dark skies should show it clearly. Walter Scott Houston, using an 8-inch reflector in southern Arizona found the field 'laced edge to edge with bright wreaths of delicately structured nebulosity'.



YOURS FREE

A full-color, self-folding atlas and portable field guide all in one

- *Contains four 13" x 16-3/4" pop-open sky maps.*
- *The maps fold back to a convenient 5"X 9' size when you're finished.*
- *Includes constellation close-ups of 55 star patterns, schedules for viewing meteors, hints for moon and planet watching, and viewing and astrophotography techniques.*

Now you can own this astronomy classic for just $1.00. It contains all objects from Charles Messier's nebulae and star cluster catalog, up-dated and annotated by Kenneth Glyn Jones. With over 350 photographs, drawings, maps, and diagrams, this invaluable guide covers everything you need to know about the 110 Messier objects! All for only $1.00.

But please, be warned. This is not a bookshelf reference. Almost all the Messier objects are visible with a small telescope, so you can make your own observations. And with more than 425 pages packed with hands-on techniques, innovative ideas, and practical information, your search for the Messier objects will be easy and systematic.

Each Messier object is explored in detail, from its history to its modern scientific description.

Find out:

- Which objects are the easiest to see
- Complete directions for finding and observing each one
- What equipment works best
- Famous astronomers' observations
- And much more

Astronomers have observed the Messier objects for over two centuries. Now you can have this easy to use handbook — current and complete — for just $1.00. So don't delay. Get your copy by mailing the completed reply card today.

Whether you're a professional or an amateur enthusiast, the ASTRONOMY BOOK CLUB offers you the finest astronomy materials available. You'll enjoy atlases and how-to manuals, as well as textbooks and popular guides covering the latest discoveries, and the opportunity to purchase them conveniently and inexpensively with prices starting as low as $9.95.

MEMBERSHIP BENEFITS• In addition to getting the MESSIER'S NEBULAE & STAR CLUSTERS for only $1.00 and the UNIVERSE UNFOLDS SPACE ATLAS absolutely FREE when you join, you'll also receive discounts on books you choose to purchase. Discounts generally range from 15% to 30% off the publishers' prices, and occasionally even more. • Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of more than 50% off the publishers' prices. • At 3-4 week intervals (15 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • In addition, up to three times a year, you may receive offers of Special Selections which will be made available to a group of select members. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

If reply card is missing, please write to the ASTRONOMY BOOK CLUB, Dept. L-DA6/62380, 3000 Cindel Drive, Delran, NJ 08370-0001 for membership information and an application.

Astronomy 4/92

© Newbridge Communications, Inc.

THE NEUTRINO NOBODY ORDERED

"I call it the neutrino from hell," says Fermilab cosmologist Michael Turner. "It is exactly what we didn't order. But if it's real, it would be the most important discovery of the last 20 years."

Neutrinos are sub-atomic particles that have no electric charge and that were thought to have absolutely no mass. But the neutrino Turner was referring to has a whopping mass of 17,000 electron volts. (Physicists use the energy of a particle to describe its mass.) New evidence for the superheavy neutrino was announced in 1991 by research teams at Oxford University, the Lawrence Berkeley Laboratory, and the Ruder Boskovic Institute in Prague. This monster neutrino steps all over the standard models created by particle physicists and plays havoc with astronomers' theories about the formation of the universe.

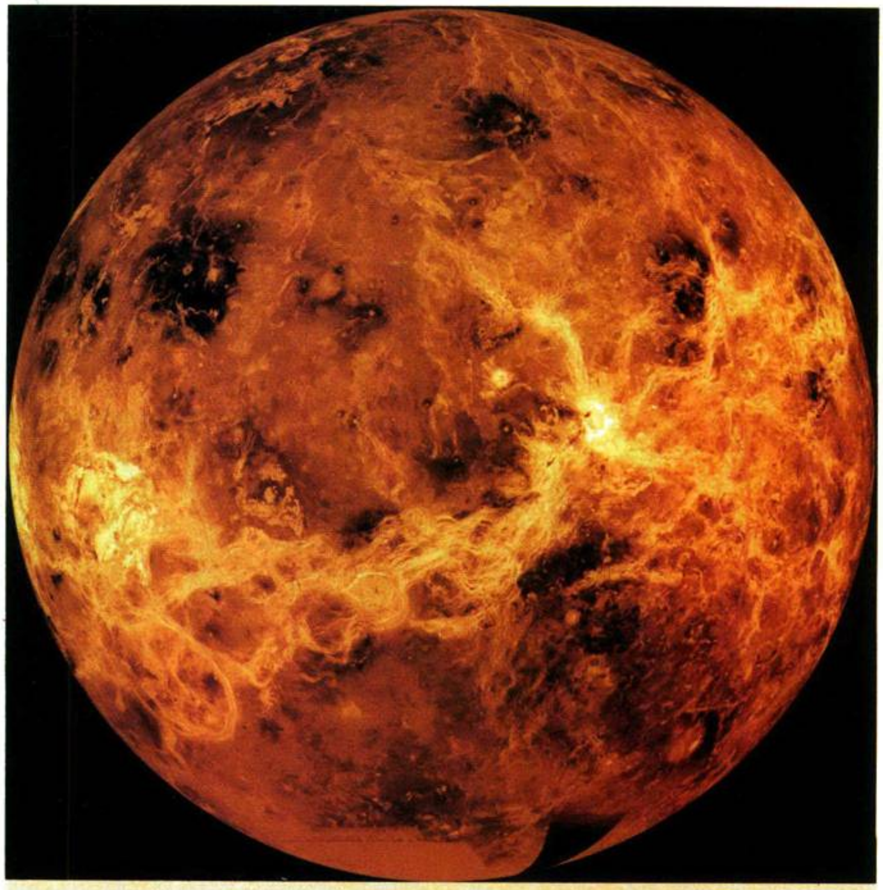
That neutrinos have mass is not a surprise. In fact it's a welcome development. Ideally, astronomers would like a neutrino with a mass of about 25 to 30 electron volts (eV). Such a particle could explain why astronomers see fewer neutrinos coming from the Sun than theory predicts. Lightweight neutrinos could also be a significant component of the mysterious dark matter now thought to make up 90 percent of the universe.

Evidence that desirable lightweight neutrinos (ones with masses of only a few electron volts) exist is piling up. The latest comes from the University of Chicago where a team of physicists observed a sample of pure uranium salt in storage since 1958. During that time, one part in 100 million trillion (10^{20}) of the uranium decayed into plutonium 238, indicating a half-life for the radioactive decay of 2 billion trillion years! Remarkably, this rate is actually faster than expected. Anthony Turkevich and Thanasis Economou of the University of Chicago and George Cowan of the Los Alamos National Laboratory announced the finding in the December 2 issue of the *Physical Review Letters.*

Theories that assume a massless neutrino predict a decay rate 100 times slower than the one Turkevich and his colleagues observed. The faster decay rate could be explained if the neutrino has a mass of about 14 eV. This is lighter than what astronomers would like but is at least in the same ballpark. Not so the 17,000 eV variety.

A neutrino that heavy makes it more difficult for astronomers to explain the number of neutrinos they observe zipping out of the Sun. It also upsets current theories of how stars behave when they explode as supernovae. Supernovae generate scads of neutrinos but a torrent of superheavy neutrinos released at the moment of the explosion would carry away too much energy, cooling off the remaining neutron star faster than what astronomers have observed.

Cosmologists are also busy calculating the effect of the 17,000 eV neutrino on their theories of the origin of the universe. As Richard Bond of the Canadian Institute for Theoretical Astrophysics explains, "This neutrino would have devastating consequences if its lifetime



REMOVE THE CLOUDS FROM VENUS and you'd see a planet streaked with lava flows. The full extent of these lengthy flows shows up in this first hemispheric image from the Magellan spacecraft. Scientists at the Jet Propulsion Laboratory assembled the global view by piecing together individual frames and mapping them with a computer onto a simulated globe. The frames are not visible-light pictures, however, but images produced by Magellan's synthetic aperture radar, a technique for "seeing" through Venus' dense clouds. Magellan's images have revealed a surface that appears to be no older than one billion years, with volcanic activity being the major agent of change, perhaps at work even today.

Magellan has completed two complete mapping cycles of Venus and began a third cycle on January 15 that will produce 3D images of the surface. However, a failure of Magellan's primary radio transmitter in January forced engineers to switch over to a backup radio, a move NASA officials say should not seriously affect the remainder of the mission. NASA/JPL photo.

JMI Pacesetters of the 90's

NEW! Announcing the "Everything you ever wanted to know about the NGT-18" video!

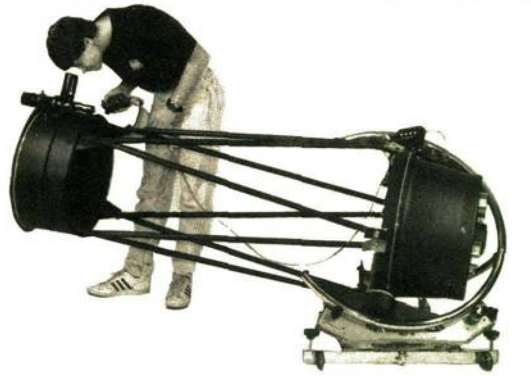
An informative, professionally produced video tape which shows you:

- **How the NGT-18 works.**
- **How it is used.**
- **How one or two people can easily move it.**
- **How well it works for astrophotography.**
- **The quality of workmanship.**
- **What accessoeries are standard.**
- **Why *Sky & Telescope* called it a "revolutionary...telescope". (January, 1991)**
- **Why *Astronomy* said it was "...the best equatorially mounted telescope we've seen in the big aperture league." (March, 1991)**
- **Why 40% are sold in Japan and Europe (not a cheap telescope after shipping and import duty!)**
- **Why it appeared in the 1990 Rolex *Awards for Enterprise*.**
- **Why it has surpassed all sales projections.**

NGT 18 Video (VHS) is $19.95 P:Pd., check or M.O., VISA or MasterCard add $5.00 Handling. Overseas add $10.00 for air mail (specify NTSC or PAL). Astronomy clubs, have your treasurer contact us for special offer.

Order line, Video tape only: 303-231-6136

Our phone lines are very busy; if you are only ordering a video tape or catalog, please use the above number, or save $5.00 fee by mailing a check or M.O.



New low deposit! Financing Available!

Institutional leasing program!

Equipped with the NGF-1 focuser.

Giant aperture yields over five times the light-gathering ability of an eight inch!

Production has been doubled on the NGT-18!

Delivery is from 2-8 weeks, depending on orders.

NGT-18D f/4.5 (Loaded, includes NGC-microMAX) **$9,600**

NGT-18AD f/4.5 (Loaded, includes NGC-MAX) **$9,900**

NGT-25 f/5 (Delivery 9 months. A $100 deposit will hold your place in line for three months.) Special introductory price **$22,500**

A 25% deposit is required to order an **NGT-18**, *the balance due prior to* shipment. The crating charge is $175; shipping varies with destination. Please specify your Latitude and the desired name for your personalized placque.

The NGT-18 may now be seen in showrooms throughout the world!

Kyoto, Japan • Kokusai Kohki • 75-321-5348 **Our No. 1 dealer with 14 NGT's!**
Paris, France • la maison de l'Astronomie • (33.1) 48.87.40.87
Augsburg, Germany • Intercon Spacetec • 49-821-414 081
U.S.A. • Scope City locations • 805-522-6646

Jim's Mobile Inc.
1960 County Road 23
Evergreen, CO 80439
800-247-0304 Orders
303-277-0304 Orders/Info
303-526-9140 FAX Line
Hours: M-Th. 8:30-5:30 Fri. 8:30-4:30

PHONE/MAIL ORDER: VISA, MasterCard, personal check, or money order. **USA & CANADA** add shipping charge shown in (parentheses) after price. **OVERSEAS:** Send VISA or MasterCard numbers with expiration date, or bank check in US$; add 5% of price for air mail shipping. Prices subject to change.

S92DP

JMI Now offers over 285,000 objects! *(in databases)*

Lowest prices ever!

We have negotiated lower prices from our computer unit supplier, and are passing these savings on to you! All of our computer units are reduced to *their lowest prices ever!*

NEW!

NGC-microMAX™

This all-new computerized setting circle replaces our ***DSC-MAX*** *unit. It has the* same RA/Dec display with only a two-star alignment, but adds an object database which includes all 110 of the Messier and many of the brightest and most interesting stars. The **NGC-microMAX** can guide the user to *any of these objects without the need to* reference any charts!

NGC-microMAX $469 ($5)

NGC-miniMAX™

A dedicated computer with **1,950** object database.

Lowest price ever!
1950 interesting objects!
C mini-MAX
Jim's Mobile Industries

- Visual magnitudes on over 1,700
- Sizes given for over 1,600
- *Over 1000 galaxies*
- 400+ open clusters
- 120+ globulars
- 120+ nebulae
- *110 Messier*
- 80 of the best stars
- 44 alignment stars
- 31 user-definable
- *Guides to objects*
- Polar align mode (not required)

NGC-miniMAX $579 ($5)

NGC-MAX™

A dedicated computer with over **8,100** object database.

NGC-MAX
Lowest price ever!
Over 1500 improvements, additions, and corrections!
ENTER
UP
DOWN

Top-of-the-line computer. Includes all 7,840 RNGC objects, 110 Messier, 241 stars, *8 planets, 25 user-definable* objects. Guide mode, identify mode, RS-232C port.

NGC-MAX $789 ($5)

SGT-MAX™

Telescope-to-PC link with over 45,000 object database.

Lowest price ever!

Full feature desk-top planetarium software with serial interface and encoders for most popular telescopes. Fantastic for observatories and *classroom demonstration.* New time skip feature allows tracing of planetary and cometary orbits *against the stellar background. For IBM* PC's with 640K, hard disk, and Hercules, CGA/EGA/VGA.

SGT-MAX $689 ($5)
Software only $109 ($3)
***NEW!!* Level III with 275,000 objects.** Requires 9MB, available on 1.2MB and 1.44MB diskettes only. *Add* **$70**

Retrofit your 'scope with these products!

With 60+ models supported, chances are we outfit yours.

MOTOFOCUS™

Focusing motors for most telescope models.

Shown are a Newtonian and LX5/6 MOTOFOCUS. Where necessary, a hand control is provided.

MOTOFOCUS $98.50 ($3)

MOTODEC™

Patented push-on and snap-on declination motors.

Motor is equipped with variable speed control. These motors are designed for use with manufacturer's hand unit or drive corrector - if you have neither, they may be ordered with a hand control (add $10).

MOTODEC $89.95 ($3)

MOTOTRAK™ III

Quartz-driven triple control (dual-axis plus focus) drive corrector, 110VAC 10W R.A. output.

Two-speed R.A., variable speed Declination/focus. **Incorporates the CCD tracker interface.** (Add $5 shipping.)

MOTOTRAK	**$269**
Battery Pack	**55**

Order Declination and focus motors at the same time and save!

MOTODEC	**$55**
MOTOFOCUS	**55**

MOTOTRAK™ G

With stepper motor R.A. drive for Meade 6600, 8800, and GEM. **$249** ($4)

NGF-1 and NGF-2

The finest focusers available - 100 times less slop than some others on the market. These 2" focusers include a 1.25" adapter and are great for any Newtonian!

NGF-1 $229
NGF-2 $169
with **MOTOFOCUS** add $70

were too long. For example, if the neutrino's lifetime were longer than 10 years it would produce too much large scale structure in the universe." If the neutrino's lifetime were shorter than a year it wouldn't affect the origin of large structures such as galaxy clusters at all.

But if it has a lifetime of 1 to 10 years, the superheavy neutrino actually helps cosmologists. It could enhance the formation of galaxy clusters in the early universe, something that current theories such as the cold dark matter models are struggling with. As Turner explains, "This neutrino could help patch up cold dark matter. It could be the neutrino from heaven."

Whether the 17,000 eV neutrino is from heaven or hell or even exists are now hot topics in the connected fields of particle physics and cosmology. Physicists are planning more precise experiments to detect the superheavy neutrino. Astronomers will be searching the data from the Cosmic Background Explorer satellite for signs of radiation produced by decaying 17,000 eV neutrinos in the early universe.

The hunt for the superheavy neutrino is on and scientists are delighting in the chase. As Bond exclaims, "If it's real, it's really exciting!" The new neutrino upsets a few theoretical applecarts, but Bond was confident — "I have no doubt that the theories will respond."

AN INTERGALACTIC HOUSE OF PANCAKES

An object that could be a long-sought-for missing link in the evolution of galaxies has been found by a team of radio astronomers. In November 1991 Juan Uson, Durgadas Bagri, and Timothy Cornwell of the National Radio Astronomy Observatory announced their discovery of a protogalactic "pancake" — a giant cloud of hydrogen gas near the edge of the observable universe. The cloud contains enough hydrogen to make a large cluster of galaxies. And indeed, the astronomers suspect that is the fate of the cloud.

The radio astronomers propose that the distant cloud is a protosupercluster, a type of object that, according to one theory, was common in the early universe shortly after the Big Bang. Such protosupercluster clouds broke up into smaller clouds that formed the strings of galaxy clusters that are common in the universe today. If the observation is correct, the protocluster cloud provides evidence for the so-called "top-down" theory of galaxy formation.

Space News

SATELLITE TO EXPLORE THE ULTRAVIOLET

One of the last windows of the spectrum to be explored is about to open wide. Sometime before the end of May a Delta II rocket will launch a new space telescope into Earth orbit. Called the Extreme Ultraviolet Explorer, or EUVE, the new satellite will probe the universe in a band of wavelengths impossible to observe from Earth and, up to now, seldom observed from space.

The extreme ultraviolet band falls between 10 and 1000 angstroms, a wavelength range slightly longer than X rays but shorter than the ultraviolet wavelengths that give us sunburns. Extreme ultraviolet (EUV) light can't penetrate Earth's atmos-phere. Nor can it travel very far in interstellar space — hydrogen gas there absorbs extreme ultraviolet light, making it difficult for us to see EUV-emitting objects beyond our local neighborhood of the Milky Way. For this reason, the EUV band was once thought to be an unproductive place to look, even from orbiting satellites.

But astronomers at the University of California at Berkeley, and others around the world, were convinced there was good astronomy to be done at EUV wavelengths. (See "The Extreme Ultraviolet: A Promising New Window on the Universe," July 1987 ASTRONOMY.) Hot stars such as white dwarfs emit EUV energy, as do close binary stars where one star is pulling material off its companion. And the hydrogen gas between the stars, the stuff that gets in the way of seeing distant targets, is worth exploring in itself. In addition, early observations in the EUV band suggested the solar system is sitting in an unusually clear bubble in the interstellar hydrogen. According to EUVE program scientist Robert Stachnik, "The boundaries of the local bubble are not known. There may be tunnels [in the hydrogen gas] that allow us to see farther into space, perhaps even out to galaxies."

Once in space later this spring, the Extreme Ultraviolet Explorer will begin mapping the entire sky. The all-sky survey will be done with a set of three telescopes. As the satellite rotates, these instruments will scan across the heavens in narrow strips. It will take six months for EUVE to cover the whole sky.

While the all-sky mapping is going on, a fourth instrument will be conducting a different type of survey. The Deep Survey/Spectrometer will map all objects in a band 180° long and 2° wide along the ecliptic. This narrow-field survey will detect objects 10 to 50 times fainter than the all-sky survey.

OPENING A NEW WINDOW in the spectrum is the task of the Extreme Ultraviolet Explorer, shown here during checkout at the Goddard Space Flight Center. The circular objects are the aperture covers for the three telescopes that will survey the ultraviolet sky. NASA photo.

After the initial 6-month surveys are over, astronomers from around the world will use EUVE to observe specific targets. This phase of the mission is expected to last at least two years. At the end of its mission, plans call for the EUVE to be retrieved by the space shuttle.

✦ Zephyr's ✦ Astronomy Software

High Quality Software! Great Prices

☐ **AstroCalc**™ - Input time/date & your lat/long and get for Sun, Moon, & all planets: Right Ascen/Dec, Alt/Azm, Ecliptic Lat/Long, Angular Size, Fraction Illum., Elongation, Orbital Elements , Rise/Set Times, Brightness, Distances from Sun & Earth. Also provided are: Local Sidereal Time, Greenwich Sidereal Time, Solar Equation of Time, Twilight Start/End. Heliocentric & geocentric data. Users manual. Thousands of satisfied users. IBM, Apple II, C64/128 **$29.95**

☐ **AstroCalc Plus**™ - All features of AstroCalc basic version plus: Automatic repetitive calculations (solar/planetary positions or any other data for every hour or day, etc.). Output as ASCII file for use in wordprocessor, etc. or printed output. Visual displays with RA/DEC views, Alt/Azm. views, heliocen. or geocen. overhead views. Configuration file saves your location, time zone, etc. IBM & compat. **$59.95**

☐ **AstroCalc Super**™ - All features of AstroCalc Plus version and: High resolution plots of Sun, Moon and planets in CGA,EGA or VGA modes. Output on screen or to laser or dot matrix printers. Get heliocentric and geocentric plots of longitude & distance or latitude and distance, RA & DEC, and altitude and azimuth. Multi-color plotting. Plots can be continuous lines or distinct points. Save selective output configuration files. Compact ASCII output. IBM,CGA/EGA/VGA **$89.95**

☐ **SunTimes**™ Generates monthly or yearly sunrise and sunset tables for any year and for any location on Earth. Get output to screen or printer. Also calculates the times of twilight(civil, nautical and astronomical) the maximum altitude of the sun and the hours of sunshine for each day. Accurate, easy to use. IBM. **$29.95**

☐ **MoonTimes**™ Similar to SunTimes but gives data for the Moon. Includes rise/set times, phase of the moon and the azimuth (or horizon position) for each rise and set time. IBM. **$29.95**

☐ **TrackSat**™ Follow Earth satellites in their orbits & predict where & when to observe them. Includes database of over 500 of the most important satellites, plus add more using standard NASA data. Gives ground tracks on a world map, plus 3-D views of Earth from space and satellites orbiting it. Get satellites plotted against star maps to plan observing sessions, and more! IBM Herc/CGA/EGA/VGA **$89.95**

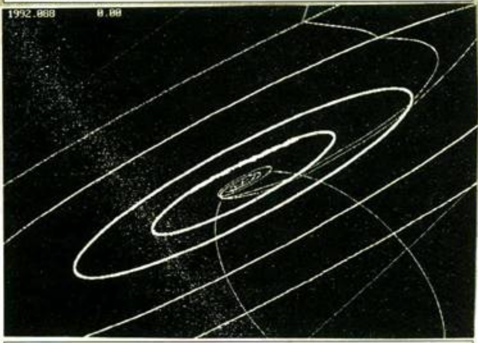
☐ **NiteMapper**™ - For any date & time generates on-screen world map showing day area in white, night area dark, & flashing symbols where Sun & Moon are directly overhead. Also shown are equator, moon rise/set line & ecliptic, lunar nodes & perigee point projected onto surface. Update information in real time, keep a fixed time, or advance conditions one hour in time every few minutes. Date & time on screen. For planning observations or educational. IBM, Apple II, C64/128 **$29.95**

Plus Version 16 color IBM EGA/VGA with alt/az & ecliptic plots **$49.95**

☐ **StarPilot**™ Pilot your personal starship through the universe! Explore our own Solar System & its planets & satellites as well as 6 imaginary star systems with planets. Hundreds of different bodies & over 50 space stations & ground bases to explore! High quality, accurate visual & flight simulation developed by professor of astronautical engineering. Fire up your engines, ease out of the docking station & head out to the Moon, orbit Saturn, land on Mars, use hyperspace to go to Novimir, Arboria, Asgard,... & other distant horizons! IBM CGA/EGA/VGA **$59.95**

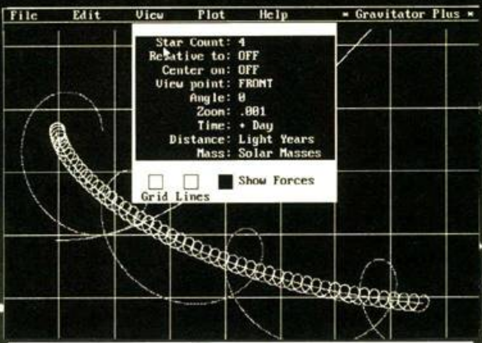
☐ **EclipseMaster**™ - Computes solar & lunar eclipse data. Accurate to 3 sec. of arc in long. & 1 sec in lat. All aspects of eclipse calculations: central line, local circumstances, area of visibility, duration, width of central line, yearly eclipse seasons. IBM, Apple,C64 **$29.95**

Plus version Generates Saros series, apsides info, more. IBM **$49.95**



☐ **Howington Orrery**™ Includes Sun, and all 9 planets displayed on screen in the correct positions for any date chosen. Halley's comet included and the Voyager I & Voyager II space probes . User's manual guides you on a tour of the solar system. See the launch of the Voyagers and the encounter of Voyager II with Neptune. Check out Halley's comet at the Sun in 1986 or look ahead to 2062. Speed of the display updates can be set from slow (1.5 hours) to fast (5.5 years) . Press keys 1 to 9 to identify each of the 9 planets on the screen. Draw the orbit of each planet or track each planet's movement with a trail on screen. PageUp/PageDn keys increase or decrease the field of view. Home and End Keys take you to Earth's orbit or to Pluto's orbit. Set time to run backwards to replay an event or to see the solar system in the distant past. This fascinating program will be a long lasting source of information and entertainment. IBM & compatibles, Hercules,CGA,EGA,VGA **$39.95**

☐ Have an original, high quality program? We may want to publish it. Please write for our Programmer's Guidelines. Please do not send software at this time.



```
   Star Count: 4
  Relative to: OFF
    Center on: OFF
   View point: FRONT
        Angle: 0
         Zoom: .001
         Time: + Day
     Distance: Light Years
         Mass: Solar Masses
```

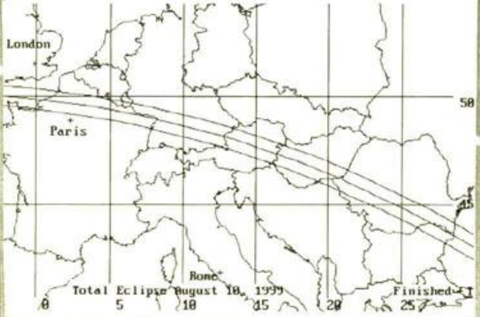
☐ **Gravitator Plus**™ - Adds these features: Uses pull-down menus and mouse(optional) for easier operations. With EGA /VGA uses 16 color mode; you can assign colors to bodies. Grid system allows better evaluation of systems. Display distances between bodies and the forces between pairs of bodies. System can be fixed to a specified body for easier tracking, more. IBM Her./CGA/EGA/VGA. Dot or laser printers. **$89.95**

☐ **Gravitator**™ - Calculates gravitational forces on astronomical bodies such as stars & planets & determines their orbits. See paths plotted & vary scale of view, orientation & angle of view. Input any set of initial conditions, use examples provided or get random sets of clusters. Save systems created to run later or try new conditions. Vary time factor to speed up or slow down simulation. Manual explains theory & use. IBM & compat., CGA or Hercules graphics **$39.95**

☐ **Personal Observing Log**™ A database of the 1160 most important deep-sky objects. Locate, research & keep records of your observations. Add or edit objects. Add detailed info, up to 16 pages per object! Use filters to get objects. Get rise/transit/set times. 31 customizable reports, output to screen, printer or file. Get map number of each object for four main atlases, Sky 2000, Uranometria, Norton & Peterson. Access the full NGC catalog of 7840 objects to find fainter objects. IBM **$79.95**

☐ **NightSky**™ For observation planning or reference get a wide variety of charts & data. Star charts with Sun, Moon, planets & deep-sky objects at variable scales, output to screen or dot-matrix. Some comets also included. Magnitude filter for stars. Center charts on a constellation. Color with EGA/VGA. Data includes RA & Dec , rise/set times, magnitude, more for Sun, Moon, planets. Simulation of Jupiter's moons. Input Lat & Long, dates 1 AD to 4000AD. IBM Herc/CGA/EGA/VGA **$79.95**

☐ **JovianTraveler**™ Go to Jupiter, Saturn, Uranus, Neptune in a simulation of the Voyager space craft missions. See the planets with moons and rings, stars, Sun & the spacecraft accurately drawn. Observe the mission from Earth, the spacecraft or the main body being viewed. Pick from seven missions to fly, including flyby of Giotto to Halley's comet. Bodies have grids & surface features to toggle on & off. Three levels of labeling. Stars can be mag limited or toggled off/on. Variable zoom factor, view, rate of travel. IBM Herc/CGA/EGA/VGA **$59.95**



☐ **SunTracker Plus**™ All features of the regular SunTracker plus: Hi-res, 16 color EGA/VGA modes. Width of totality path is visible on screen by plotting the bounds of totality = 100%. Eclipse paths plot in black for total eclipses; annular paths in white. Bounding lines are red, oceans blue and land areas are green. Accepts as input the Saros number, a numbering convention for 18 year intervals between similar eclipses. Use Saros numbers to watch a series of eclipses. A Saros series table for 5729 BC to 6627 AD is included. Screen includes path summary table, date of the eclipse and Saros numbers. Above illustration is Super version. Plus uses full world maps(various orientations)IBM EGA,VGA. **$49.95**

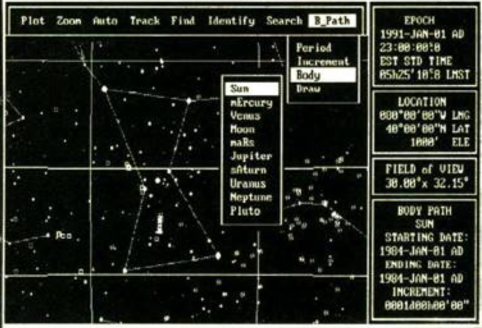
Super version Plots eclipse paths on variable scale maps in color. You give center of map & overall size in long./lat. Add titles, cities,etc. Plus version included as part of Super version. IBM EGA/VGA. **$89.95**

Regular version does calculations and basic B&W world map plots and tabular data of central line, duration, etc. IBM CGA, Apple II, C64 **$29.95**

☐ **Astronomy Lab**™ Learn astronomy with your computer. As the 70 page manual text explains a topic simulate it on screen. Functions include: 6 sky views, 12 graphical charts, 12 event reports. Explains solar and lunar eclipses, transits of Venus and Mercury, occultations of stars, Jupiter & its moons, seasons & equinoxes, calendar, coordinate systems & more. IBM, harddisk or 1.2 m or 1.44 m floppy, EGA/VGA **$59.95**

☐ **GalaxCrash**™ Simulate the collisions of galaxies on screen. Computer calculates the gravitational forces on the stars so that they move in accordance with Newton's laws of motion to show the typical results of colliding galaxies: whirlpools, rings, bridges and other structures. You specify the number of stars in the first galaxy & the mass, location and the velocity of the second, galaxy. IBM CGA **$29.95**

Plus Version Uses 16 color EGA or VGA graphics, assign colors, scale view, get PCX file output and more. IBM EGA/VGA **$49.95**



```
EPOCH
1991-JAN-01 AD
23:00:00.0
EST STD TIME
05h25'10.8 LMST

LOCATION
000°00'00"W LNG
40°00'00"N LAT
1000'  ELE

FIELD of VIEW
30.00°x 32.15°

BODY PATH
SUN
STARTING DATE:
1984-JAN-01 AD
ENDING DATE:
1984-JAN-01 AD
INCREMENT:
0001d00h00'00"
```

```
Partial Solar Eclipse
Magnitude: 0.170  Obscuration:  8.3%
LAST CONTACT
```

NGC 3034 Located at TARGET
Galaxy
UMA
9.5
11'x 5'
(CIRCUMPOLAR)
(CIRCUMPOLAR)

☐ **LodeStar Plus**™ All features of 2.1 version and these additions: High resolution 16 colors with EGA/VGA modes. Includes all 7840 NGC galaxies, clusters, nebulae, etc. Options to plot RA&Dec grids and constellation boundaries. Automatically search for and see solar and lunar eclipses, planetary conjunctions, occultations. Plot the paths of Sun Moon & planets on sky view. Video mode lets you record screens to display later for reference or demonstrations. Calculates parallax, nutation and aberration and ephemeris time corrections for high accuracy. Supports any of 300 printers, dot, laser or jet. Sophisticated interface including pull-down menus and mouse support to easily access all 78 functions. IBM & compat. 512K, Hercules, CGA/EGA/VGA. Works with or w/o co-processor. 16 colors w/ EGA/VGA **$149.95**

☐ **LodeStar Plus II** Added features include: Add your own objects in a user database. Assign names to user objects and create detailed images of objects(examples included). Find bright stars, constellations and user objects by name. Optional SAO star database includes 259,075 stars (all stars down to mag. 11.9) for more detailed sky views and charts (needs 8.5 meg hard disk space). Uses more custom assembly language routines for faster operation. **$199.95**, with SAO database **$229.95**

☐ **LodeStar**™ **2.1**- Get accurate, variable size views of the sky for any date & time from 9999BC to 9999AD for any location on Earth. Includes over 9,000 stars(all naked eye and some to mag. 7.8), Messier objects & Sun, Moon & all planets. Investigate past, present and future with LodeStar! Choose any size view from 180 deg. to 0.18 deg., with or w/o constellation lines. Set limiting mag., option for colored stars & size proportional to magnitude. Sun, Moon & planets show actual size & phase at high magnifications. See solar eclipses, planetary conjunctions, occultations, transits, etc. Scroll to any object to recenter display or zoom in or out. Use target to identify stars or objects & get RA/Dec, Alt/Az, Rise/Set & transit times. Calculates refraction, precession, parallax.

- ✦ Automatic tracking and plotting at solar, lunar or sidereal rate
- ✦ Simulates daytime, twilight or night sky for date, time, location
- ✦ Image can be normal or reversed as in telescope eyepiece
- ✦ Star Data: HD#, Flamsteed #, Constel., magnitude, color
- ✦ Sun, Moon & Planets: Geocen. lat. & long., ang. size, phase

IBM or compat., 384K, CGA. Works with or w/o co-processor. **$89.95**

☐ **AstroInfo**™ High accuracy data for the Sun, Moon and all planets. Most results accurate to seconds of arc. Select any date from 999BC to 4000AD and any latitude and longitude. Provides position in sky, brightness, rise/set times, & much more. Do searches for conjunctions of Sun, Moon & planets (specify separation), distances from Earth. and locations in the sky(specify RA & Dec boundaries). Generates ephemeris tables to screen, printer or ASCII files IBM & compat. **$49.95**

☐ **AstroStell**™ - Teaches you all 88 constellations plus deep sky objects. Includes: Call constellations by name to screen, Random display to guess names, & magnitudes of bright stars, Deep sky objects(galaxies, star clusters, nebula, double stars), Classical lore. Input date/time, & get constellations visible. History of constellations & star charts. Observing tips & how to use a telescope. IBM, Apple II **$29.95**

Plus Version Graphical display for more realistic views. Stars connected by lines to form constellation shapes. Colors with EGA/VGA. Additional info on stars and constellations. IBM Herc./CGA/EGA/VGA **$49.95**

MasterCard

Plus 112 More Excellent Programs!

VISA

Order Today!

☎ 1-800-533-6666 ☎

24 Hrs 7 Days a Week FAX Orders to 412-422-9930

For Info or in PA Call 412-422-6600

By phone or mail. Check, M.O., credit card(#&expir.). Add $4 shipping($6 overseas). PA add 6%. Give computer type. Add $1/prog. for 3.5"IBM. Join tens of thousands of satisfied customers in 50 states & over 100 countries. Fast shipment!

Zephyr Services

The Leading Astronomy Software Publisher

ZS

1900 Murray Ave. Dept. B
Pittsburgh, PA 15217
FREE Catalog-Call or Write

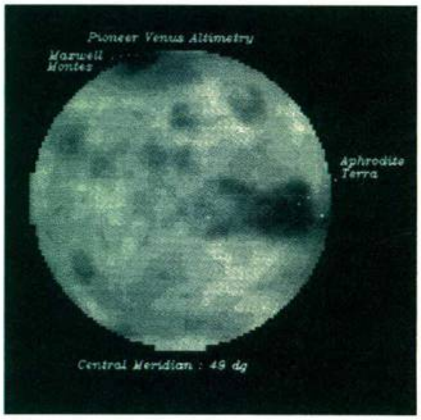
Our 11th Year

This model says that clusters of galaxies formed because large clouds split apart. The alternative "bottom-up" theory claims that galaxies and clusters of galaxies formed from the merger of smaller collections of matter. The bottom-up model has held sway over the last 20 years but has run into trouble accounting for the size and extent of the structures astronomers are now finding in the latest surveys of galaxy clusters. (See "Beyond the Big Bang" on page 30.)

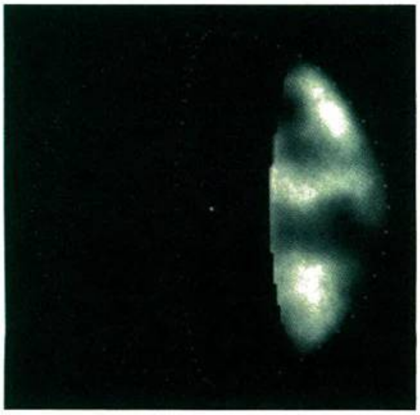
The top-down theory was developed by Yakov Zel'dovich of Moscow State University who predicted the existence of flattened pancakes of hydrogen at great distances from Earth. Because they are billions of light-years away we would see them as they appeared billions of years ago. Since 1986, Uson, Bagri, and Cornwell have been using the Very Large Array radio telescope in New Mexico to search for Zel'dovich pancakes. (Neutral hydrogen emits energy in the radio frequency band, thus the need for radio telescopes for the search.) Each of their searches scanned a volume of space equal to 10 million billion billion (10^{25}) cubic light-years! The observed cloud is thought to be about 5 million light-years across, large on the scale of galaxies but tiny compared to the volumes of space searched. The team plans to continue looking, hoping to find more Zel'dovich pancakes.

VENUS SURFACE PHOTOGRAPHED FROM EARTH

A team of astronomers working at Pic-du-Midi Observatory in France has taken the first Earth-based images of Venus which show features on the planet's surface. The team consisted of J. Lecacheux (of Meudon Observatory), F. Colas (Bureau des Longitudes), P. Laques and F. Deladerrière (Pic-du-Midi), and P. Drossart (Meudon).



APHRODITE TERRA SHOWS DIMLY as a dark region in this Earth-based infrared photo taken through the Venusian clouds (above); compare with the Pioneer Venus topography shown at the same scale and orientation (below). Images courtesy Pierre Drossart.



Amateur News

Okie-Tex '91: Mission Accomplished

The task seemed impossible — observe a planetary nebula which glowed at a barely perceptible magnitude of 16.0 yet spanned 240 arcseconds, gigantic for this type of object. For four days last October, amateurs attending the 8th annual Okie-Tex Star Party tried but failed to see this elusive object. October 5 was the final night and the clearest one yet, but would it be enough?

The challenge was laid down by James Kaler of the University of Illinois. As one of the guest speakers at the Okie-Tex Star Party and a specialist in planetary nebulae, he offered the test. He had failed to observe visually Abell 80, also known as PK 102-05 1, with his university's 40-inch telescope.

Though the largest telescope at Okie-Tex, sponsored by the Oklahoma City Astronomy Club, was 25 inches, amateurs never say never. Kaler provided copies of the appropriate photo from the Perek-Kohoutek *Catalogue of Galactic Planetary Nebulae* to serve as a finder chart. On the last night of Okie-Tex '91 Barbara Wilson and Larry Mitchell, both of the Fort Bend Astronomy Club, observed through their 20-inch f/5 and 25-inch f/4 telescopes, respectively. The star field around Abell 80 succumbed rather easily; the planetary proved more elusive. Finally, Barbara shouted "Oh, there it is!"

Larry swung his telescope to the spot and verified her sighting. But the real confirmation was still to come. Would Kaler verify it? He stared into the eyepiece for several silent, agonizing seconds. Suddenly, "Wait, there! It just popped into view. I can't see it now, but it was definitely there."

The victory over Abell 80 capped an incredible five days and nights of activities and observing that left the 200 participants tired but happy. For the second year, members of the Collins Radio Club of the Dallas area set up a 60-foot mobile antenna and an assortment of ham radio gear. Throughout the star party, the hams, Steve Coleman, Larry Slay, Clyde Heath, and George Huling contacted other amateurs around the world. The radio linkup included contact with the New South Wales, Australia, astronomy club star party.

Okie-Tex participants also had personal contact with Australian amateurs. Max and Wilhimena Gardner, members of the New South Wales Astronomy Club whom we had contacted by ham radio at last year's Okie-Tex, were able to attend this year's event in person. They are planning a similar large amateur event in Australia next year and wanted to learn how star parties in North America are organized.

The clear, dry observing conditions at this year's Okie-Tex left participants wanting more, and nearly all promised to return for next year's event, scheduled for October 19 to 25 at the Prude Ranch near the McDonald Observatory in Texas. — *Wayne Wyrick*

Astronomical Innovations

Where Bright Ideas Become Profitable.

P.O. Box 14853 ● Lenexa, KS ● 66285

1-800-473-SETA

FREE CATALOG

Call now for our catalog with all new innovative products. We have over 11 new product lines to choose from.

BINOCULAR-MOUNT - Portable & rock steady for any equipment up to 10 lbs. Total azimuth & latitude control. Objects stay centered at any observer's height. "L" bracket required. **$119.95**

PORTA-PIER - Light weight but solid total stability. 40 lb capacity Breaks down without any tools for compact storage. Top head drilled to 1/2" x '3 thread. 44" height. **$124.95**

DEW SHIELDS - Protect those special coatings with these hard plastic dew shields. Finished in black leatherette vinyl. Fits all 80mm brand names. **$18.95**

SOL-MATES - Top quality solar mylar yields true white image of sun. Designed to fit DS - 80 dew sheilds left. Sold separately or save $5.00 when purchased with dew shields. **$34.95**

NCP-FINDER - Glow-in-the-dark 7 inch diameter finder to use with your Telrad® or any telescope. Hard bond plastic with accurate .82° NCP alignment. **$11.95**

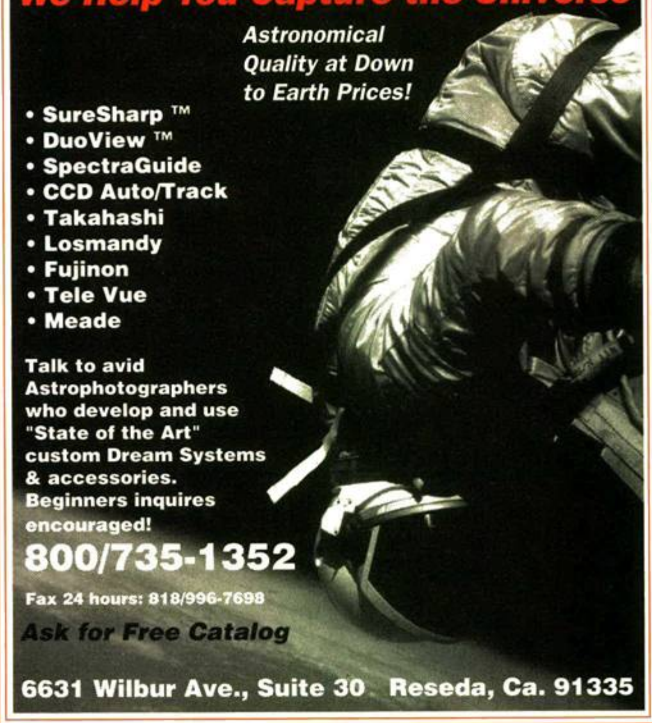
FILTER TRAY - Holds 9 - 1-1/4" and 3 - 2" filters plus one 8" to 9 -1/2" solar filter. Includes dust cover and 20 decal identifyers for customization. **$19.95**

All Products are 100% Guarenteed

All orders, Please add 6% shipping and handling

Kansas residents add 6% sales tax

ASTRONOMICAL INNOVATIONS Was created by amateur astronomers for amateur astronomers to help promote inventive ideas and make them profitable. We have capabilities in: Plastics, Metals, Castings, Wire, Silkscreening, Machining, and Packaging. All contracts guarantee your protection as an inventor and you receive increased royalties if your product sells.



Spectra™ Astro ⋆ Systems

Astrophoto Specialists

We Help You Capture the Universe

Astronomical Quality at Down to Earth Prices!

- **SureSharp ™**
- **DuoView ™**
- **SpectraGuide**
- **CCD Auto/Track**
- **Takahashi**
- **Losmandy**
- **Fujinon**
- **Tele Vue**
- **Meade**

Talk to avid Astrophotographers who develop and use "State of the Art" custom Dream Systems & accessories. Beginners inquires encouraged!

800/735-1352

Fax 24 hours: 818/996-7698

Ask for Free Catalog

6631 Wilbur Ave., Suite 30 Reseda, Ca. 91335

SOLAR SKREEN®

SUPER, HELICAL FOCUSING 50mm AND GIANT AMICI PRISM 80mm FINDERS

TUTHILL, YOUR ASTRONOMICAL FRIEND SAYS:

WE SELL ALL CELESTRON & MEADE TELESCOPES & ASTRONOMICAL PRODUCTS. Call us toll FREE (1-800-223-1063) and we can discuss your needs in detail and give you unbiased information on these and other scopes.

• • • •

Our SOLAR SKREEN® Sun filters (Pat. #3,897,140) are the only ones with internal, metallic surfaces sealed against moisture. Glass solar filters have easily-scratched exposed coatings. Our SOLAR SKREEN® assemblies now come with a FREE color-correcting filter. To see the quality of SOLAR SKREEN® results, see the picture pg. #440 in Oct. 1991 *Sky and Tel.* and pg. #686 in Nov. 1991 *Sky and Tel.*

• • • •

Hundreds of amateurs are still wasting time in useless attempts to accurately level their SCT tripod. Are you one of them? Forget leveling!! Use PRECISION POLAR AXIS FINDER and easily get EXACT polar alignment in minutes, making setting circles a snap to use.

• • • •

Are you wasting valuable, limited, viewing time trying to combat dewing on your SCT corrector plate? Our moisture absorbing, NO DU CAPS, which are heatable and light-weight, keep the air dry near your corrector thereby increasing your pleasure instead of your frustration.

• • • •

OUR GIANT, AMICI PRISM, CORRECT-IMAGE, 50mm & 80mm FINDERS fit any scope and easily give a correct finder view to match your sky chart view. Each FINDER has a focusable 1¼" eyepiece equipped with a rubber eyecup.

PRECISION POLAR AXIS FINDER®

NO-DU CAPS®

THESE ARE THE ONLY DEW CAPS THAT ABSORB MOISTURE

Send 9" x 12" SASE (4 stamps) for our complete information and FREE SOLAR SKREEN® sample.

Call Toll FREE 1-800-223-1063. In NJ 908-232-1786. FAX 908-232-3804. Time payment, Check, MO, COD, Visa, & MasterCard.

Roger Tuthill, Inc., Box 1086-A, Mountainside, NJ 07092

The images, taken in September and October last year, were made at an infrared wavelength of 1 micron, where the Venusian atmosphere is relatively transparent. When the team compared the images of Venus' night side with the planet's surface topography (as revealed by the Pioneer Venus spacecraft's altimeter), they detected a large, dark feature that corresponds in location to the equatorial continent Aphrodite Terra. Because this landmass has elevations that reach up to 5 kilometers above the average Venusian surface, the team attributes the darkness of the feature in their infrared images to cooler ground temperatures at high altitude.

DID A COLLISION BREAK BIELA'S COMET?

First observed in 1772, Biela's Comet was a normal comet with a 6.6-year period when it was observed passing the Sun in 1806, 1826, and 1832. But on its 1846 return, astronomers were startled to find that it had split in two, with both halves following the original orbit but separated by hundreds of thousands of kilometers. The pair was seen again in 1852, by then traveling two million kilometers apart. That apparition was the last time either part was seen, and a full explanation of what happened to Biela's Comet has never been found.

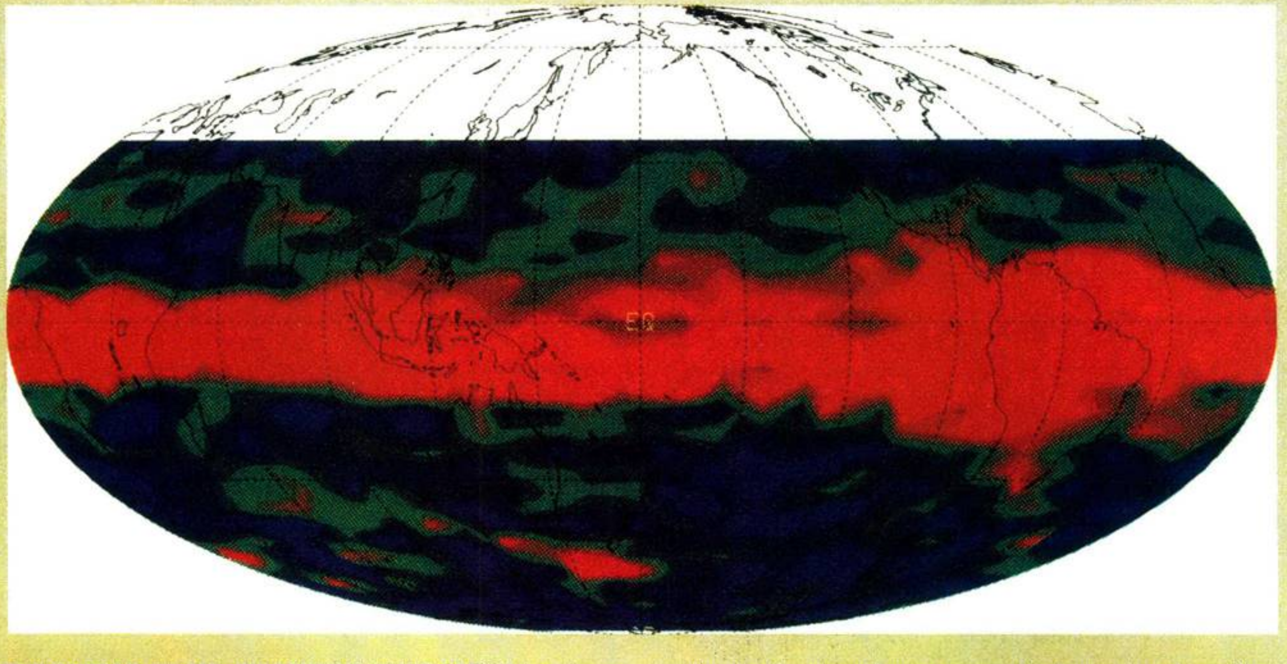
Recently, astronomer Iwan Williams of Queen Mary and Westfield College in England studied the problem in collaboration with three other astronomers. Writing in the November 1, 1991 issue of the *Monthly Notices of the Royal Astronomical Society*, the group retraced the comet's orbital history. They found that in late 1832, Biela's Comet most probably collided with the swarm of meteoroid particles that causes the Leonid shower every November. This swarm comes from another comet, Tempel-Tuttle (which, however, was not near Biela's Comet at the time).

But the astronomers are not sure whether the collision with the meteorid swarm would have been enough to break Biela's Comet in two. While a high-speed passage through the swarm would have shot-blasted the comet, the particles in the swarm are just specks of dust with very little mass. The team concluded that the splitting of the comet around the time it passed through the Leonid swarm may have been mere coincidence.

As comets warm under the influence of the Sun, say the researchers, they sublimate their ices and slowly change shape, becoming markedly irregular. Spinning as it orbits the Sun, an aging comet might break in two simply because its mechanical strength was no longer enough to hold it intact. One of the research team, David Hughes of Sheffield University, remarks that comets have about a 1 in 300 chance of doing this naturally each time they swing close to the Sun.

PULSING PRE-WHITE DWARF STAR

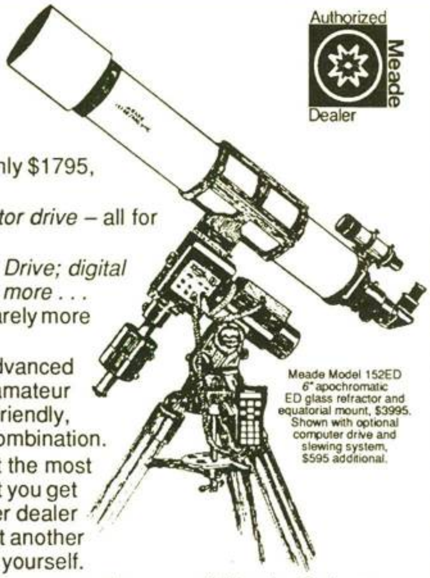
Thirty astronomers have observed McGraw's star and found that it pulses at over 100 frequencies, allowing astronomers for the first time to probe the inside of a star other than the Sun. The pulsation periods range from 385 to 1,000 seconds. This discovery is unique



THE SPREAD OF MT. PINATUBO'S DUST CLOUD has been mapped by NASA's new Upper Atmosphere Research Satellite (UARS). In June 1991 the volcano in the Philippines injected massive amounts of sulfur dioxide into the atmosphere where it now lingers at a height of about 15 miles. The concentrations of sulfur dioxide, shown here as areas of red, were largely confined to the tropical zones when UARS made these measurements in late 1991. However, the sulfur dioxide is spreading north and south and is now bringing unusually red "volcanic sunsets" to temperate latitudes. NASA photo.

Meade *Advanced Products* turn the telescope world upsidedown!

Authorized Meade Dealer



Meade Model 152ED 6" apochromatic ED glass refractor and equatorial mount, $3995. Shown with optional computer drive and slewing system, $595 additional.

Imagine a 4" apochromatic ED glass refractor – *complete with equatorial mount* – for only $1795, barely more than the price most manufacturers charge for a 4" optical tube alone.

Imagine an 8" reflector – *with equatorial mount, setting circles, finderscope, and motor drive* – all for under $600, barely more than the cost of a simple 8" Dobsonian.

Imagine a 10" Schmidt-Cassegrain – *with 8° per second pushbutton slewing; Smart Drive; digital readout; a built-in deep space object locating and identifying computer; and much, much more . . . a telescope that will track flawlessly with no polar alignment needed* – all for under $2300, barely more than the cost of an ordinary 8" Schmidt-Cassegrain.

If you can imagine all these, you've still just imagined only a few of Meade's new Advanced Products – more than a dozen new, innovative, and *affordable* telescopes that will turn amateur astronomy on its head. Now imagine these Meade Advanced Products combined with the friendly, knowledgable mail order service that has made Astronomics famous. That's a winning combination.

Astronomics. No tall tales, phony prices, obsolete merchandise, or surly clerks. Just the most advanced equipment, plus honest and unbiased advice from friendly people who *care* that you get the scope that's right for you – *at a price you can afford.* It's refreshing to find a mail order dealer who is friendly, competent, honest, and treats a customer as a human being instead of just another chance to make a quick buck. But we're all those things at Astronomics. Try us and see for yourself.

Send a stamped self-addressed envelope (75¢ postage) for our price list 92A showing your savings on all Meade, Celestron, Edmund, Questar, and TeleVue telescopes and accessories; an 8-page information-packed brochure on how to pick the right scope; unadvertised special sale bargains; and much more. It will be the best 75¢ you'll ever invest in astronomy.

astronomics

Our 13th year of friendly service, good advice, and money-saving prices.

2401 Tee Circle, Suites 105/106, Norman, OK 73069

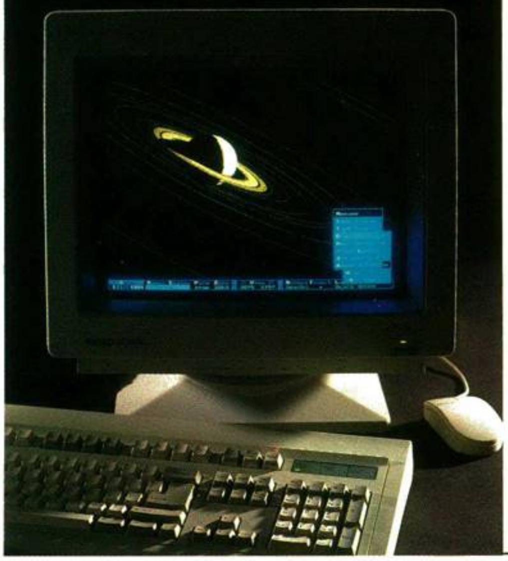
Toll-Free Order Line: **(800) 422-7876**
Use (800) 422-7876 for price quotes and credit card orders only.

Tech Questions/Customer Service: **(405) 364-0858**
Use (405) 364-0858 for tech advice and all calls from AK, HI, PR, OK, and Canada.

Hours: Monday thru Friday, 10:00 AM to 5:00 PM CST.
Mastercard, Visa, Discover, Optima, and American Express.
3% freight on credit card orders. $3 service charge on orders under $25. $5 per carton COD charge. U.S. and Canadian sales only.

DANCE OF THE PLANETS™

SPACE TRAVEL FOR THE INQUIRING MIND



Next Generation Astronomy Software Today

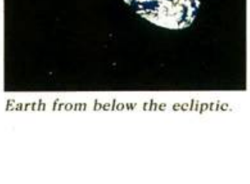
An Interactive Model of the Dynamic Sky and Solar System

> No other PC program gives you a better sense of the utterly graceful chaos of our solar system than *Dance of the Planets*… More important, though, is how it helps you make sense of the night sky. Your appreciation of stellar bodies grows each time you run *Dance*.
>
> Gregg Keizer, **Compute**

> It's an order of magnitude better than any other solar system simulator on the market.
>
> John Mosley, **Sky & Telescope**

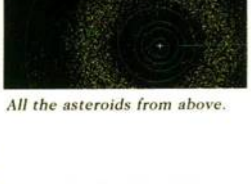
> It is the most imaginative and imagination-inspiring software that I have yet seen running on a PC… It is, I believe, possible to learn more about astronomy in a few short hours with *Dance* than in years of studying dry textbooks.
>
> Richard Berry, **Astronomy**

> This reviewer has encountered no similarly rich entrant in the existing corpus of programs for the personal computer.
>
> Philip Morrison, **Sc. American**



Earth from below the ecliptic.

The southern sky with skylines.

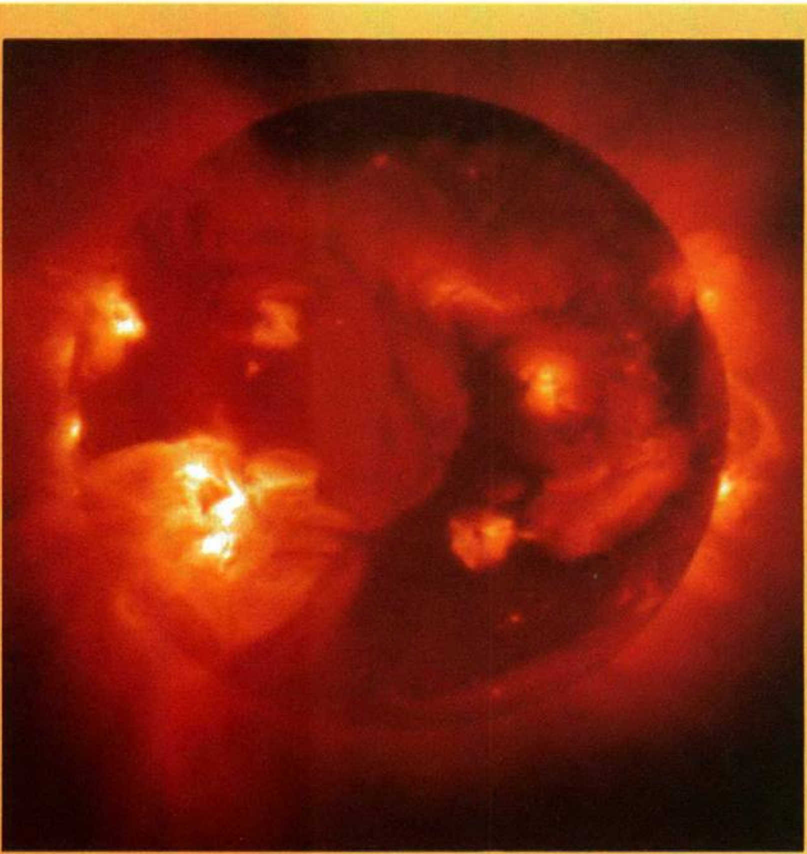


All the asteroids from above.

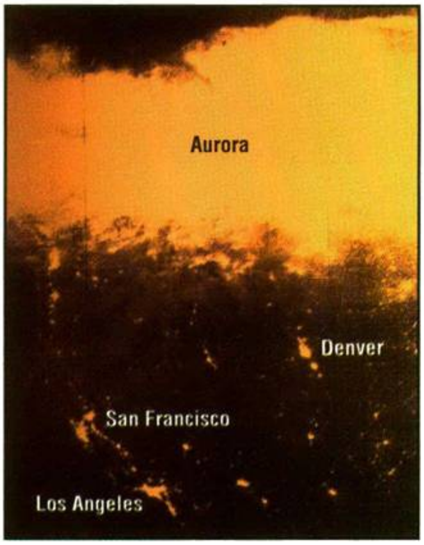
1-800-SKY-1642

A.R.C. Science Simulation Software • P. O. Box 1955E, Loveland, CO 80539

For IBM compatibles, 640k, EGA/VGA, HD. Math co-processor highly recommended.
v2.5 $195 + s&h. Literature available. Phone 1-303-667-1168, Fax 667-1105



THE SEETHING X-RAY SUN was captured by a new Earth-orbiting satellite built by Japan. Launched August 30, 1991, from Japan's Kagoshima Space Center, the satellite is called Yohkoh which means "Sun-ray" or "Sun-beam." Two of Yohkoh's instruments, the Soft X-Ray Telescope and the Hard X-Ray Telescope, are collaborative projects with the United States. On October 25, 1991, the soft X-Ray instrument recorded this image of the active Sun. Dark regions are quiet holes in the Sun's corona. Bright regions are sites of intense magnetic activity. The region at lower left produced several large flares as the Sun's rotation carried it across the disk over the following week. One result of this activity was the great aurora of November 8, 1991. Photo courtesy NASA and the Japanese Institute of Space and Astronautical Science.



THE NIGHT OF THE AURORA, November 8, 1991, was captured by the U.S. Air Force's Defense Meteorological Satellite. Using amateur radio gear, meteorologist Hank Brandli was able to receive the images from the satellite and assembled this montage covering western North America. The images, taken at 7 p.m. PST, show the aurora blanketing all of Canada and much of the northern states, areas where the aurora appeared over the entire sky. Sites farther south would have seen the aurora confined to the northern sky. The Defense Meteorological Satellite orbits at 450 km and is the only satellite equipped with the low-light sensors needed to capture visible-light images of Earth at night.

for another reason: the observations were obtained with the Whole Earth Telescope, a worldwide network of about 12 observatories. To determine the pulsation frequencies, the astronomers measured the star's brightness every 10 seconds for 160 hours. The global network of telescopes ensured that there would be no gaps in the data.

McGraw's star (PG 1159–035 — the numbers refer to the star's position in the sky) is a pre-white dwarf star located about 1,000 light-years from Earth. The star long ago used up its nuclear fuel and is collapsing to its final endpoint, a crystalline sphere about the size of Earth. As reported by the study's principal investigator, Donald Winget of the University of Texas, in the September 1, 1991 *Astrophysical Journal*, the pulsations of the star enable its mass (0.586 solar mass) and its rotational period (1.38 days) to be determined with an accuracy unparalleled for other stars. Further analysis of the pulsation observations may make it possible to uniquely determine the interior structure of the star.

DUST DISKS AROUND MORE STARS

When Infrared Astronomical Satellite (IRAS) observations revealed a dust disk around Beta Pictoris, astronomers were excited because it was one of the first dust disks discovered. IRAS eventually found only eleven more stars with dust disks. But recent observations reported in the December 1991 issue of *Astronomy and Astrophysics* by Helmut Holweger and S. Stürenburg of the University of Kiel in Germany suggest that more young stars have dust disks.

The astronomers observed eight Lambda Bootis stars, a class of stars believed to be unevolved, metal-deficient stars of spectral type A. One of these stars showed absorption lines in its spectrum that may arise from a circumstellar disk of material. Although the lifetimes of Lambda Bootis stars are too short for planetary systems to form from the dust disk, researchers can now study the size, temperature and content of an additional dust disk and gain further insight into the planetary formation process. □

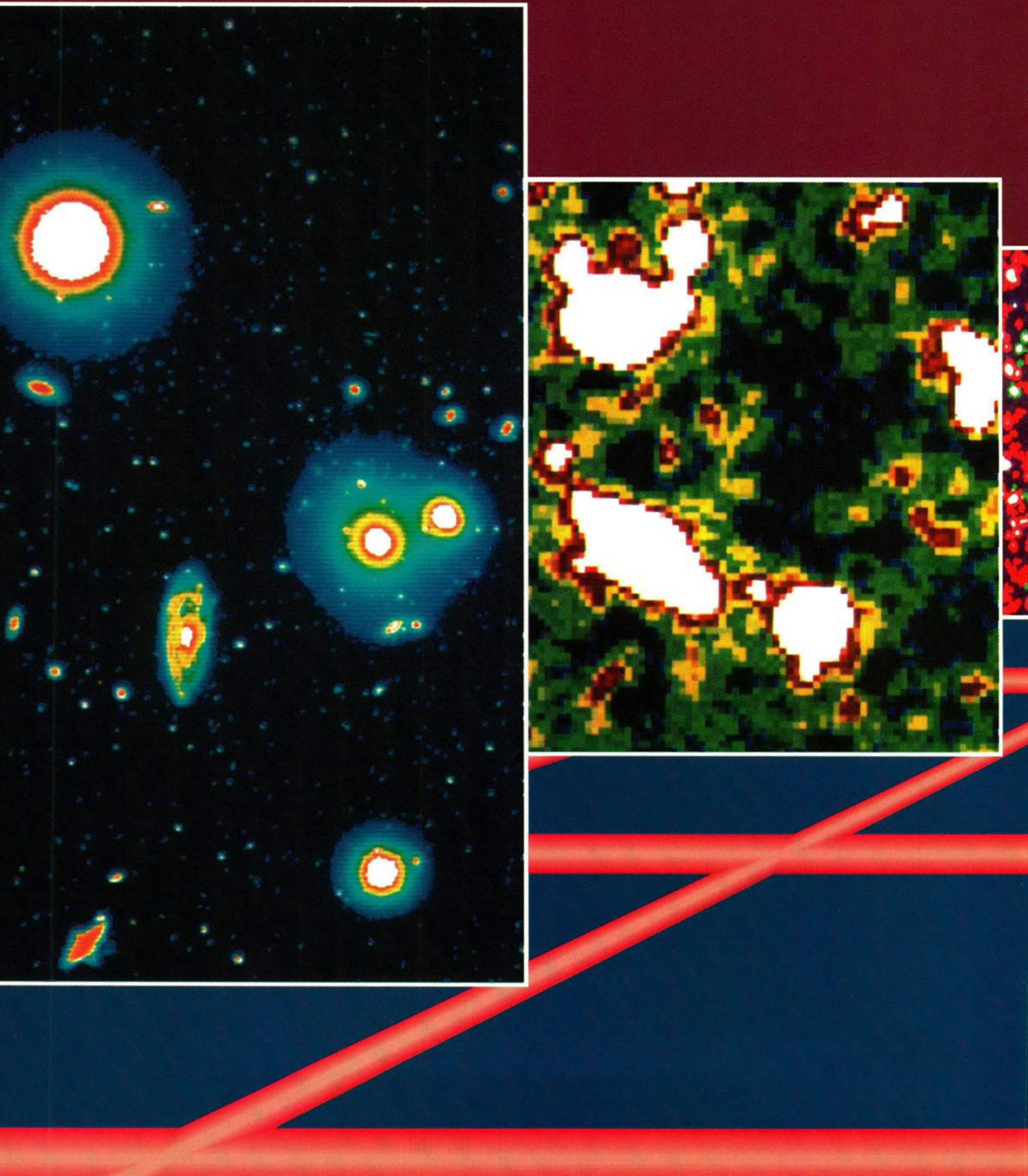
PANOPTIC

Tele Vue Panoptic™ Eyepiece System. Tack-Sharp Panoramic Viewing

Another step toward the "spacewalk" experience. Using very high index glasses, Al Nagler's new design has dramatically extended low-power eyepiece performance. Panoptic has far more tack-sharp imagery than any eyepiece in its class. The 68° apparent field 35mm (2"), and 22mm (2"/1¼") models feature grip rings, eyeguards, and new protective lens caps. When used with the Tele Vue 2x Big Barlow and the new Panoptic interface lens, you obtain 17mm and 11mm focal lengths with image quality rivalling the revolutionary Nagler eyepieces. All this with plenty of eye-relief. For eyeglass wearers, there's no better choice. The Panoptic eyepiece system by Tele Vue. Even better than you imagined!

Tele Vue™

Send for full-line literature, please include $3 for postage and handling.
Tele Vue Optics, 20 Dexter Plaza, Pearl River, NY 10965. (914) 735-4044.

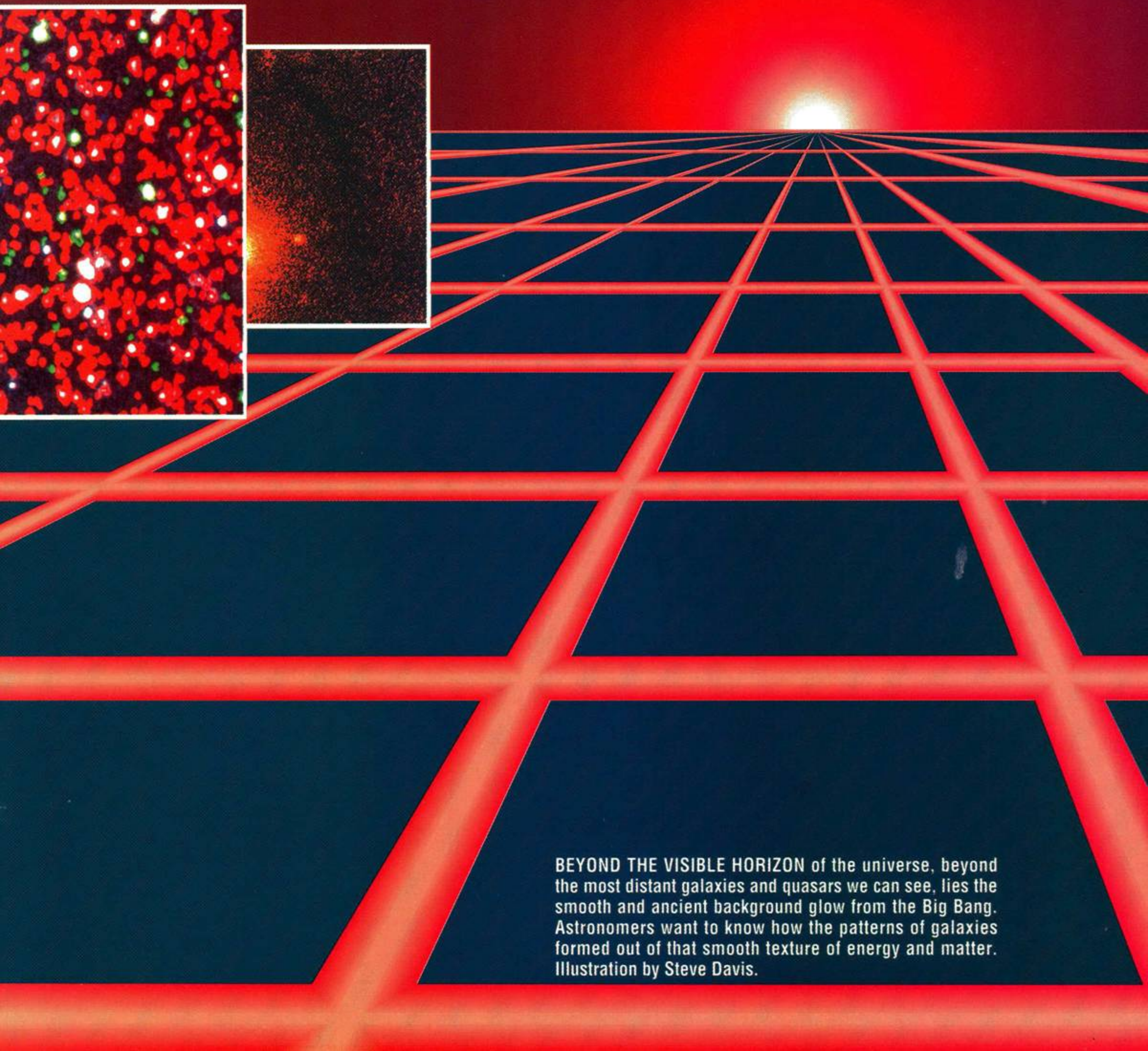


COSMOLOGY

Beyond the Big Bang

New observations cast doubt on conventional theories of how the universe formed.

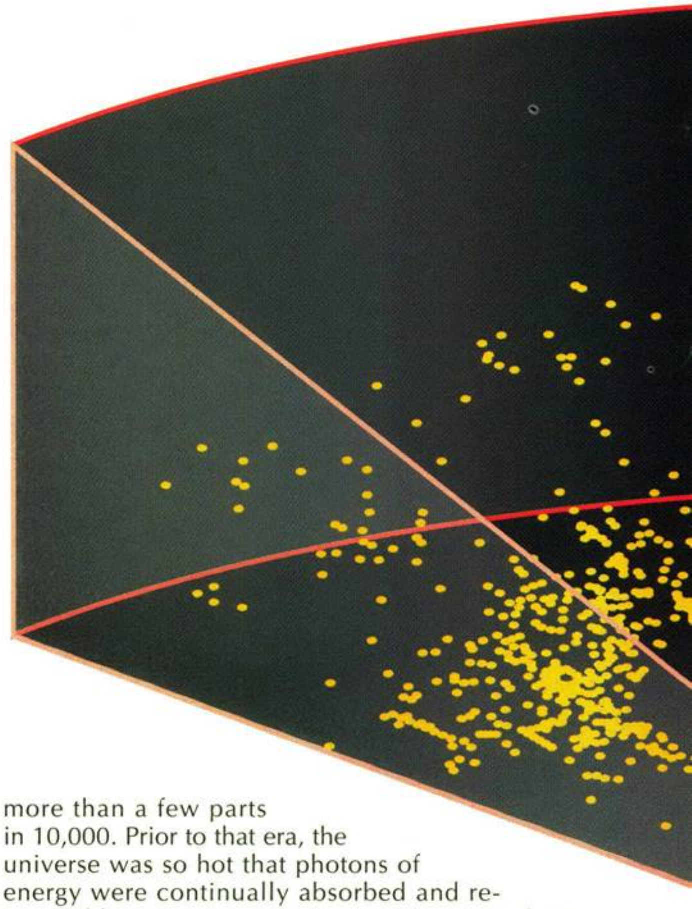
By Jeff Kanipe



BEYOND THE VISIBLE HORIZON of the universe, beyond the most distant galaxies and quasars we can see, lies the smooth and ancient background glow from the Big Bang. Astronomers want to know how the patterns of galaxies formed out of that smooth texture of energy and matter. Illustration by Steve Davis.

"It seems to be gratuitously courting disaster to expose our theories to conditions in which any slight weakness is likely to become magnified without limit. But that is just the principle of testing."

— *Sir Arthur Eddington,* The Expanding Universe.



On November 18, 1989, the Cosmic Background Explorer (COBE) was launched into Earth orbit. Its mission: to study the dominant form of radiation in the universe, the cosmic microwave background that is believed to be the remnant heat from the Big Bang itself.

In just nine minutes of observations, COBE determined that the cosmic background radiates at a temperature of just a little over two and a half degrees above absolute zero. More importantly, it showed that the intensity of the background across the spectrum precisely matches that of a perfect emitter and absorber of radiation — an idealized object physicists call a "blackbody."

The COBE results were a stunning victory for the standard Big Bang model of the universe. Here was evidence that the primordial fireball was a uniform explosion of matter and energy. Out of a quantum seed the universe unfolded with the grace of a tropical blossom, balanced and smooth, but with all the structural attributes of a seaside fog. For astronomers, however, the COBE results added to a growing paradox in cosmology.

Paradox Found

The problem stems from COBE's confirmation that the background radiation is coming at us with equal intensity everywhere we look. This demonstrates that the early universe must have been smooth — matter and energy were once evenly distributed.

This is hardly the case today. You need only walk out into your backyard at night and explore the sky with a telescope to see that for yourself. The local universe is not smooth. Neither is the more distant universe we can see with giant telescopes. Lumps of matter exist in the visible universe — they're called galaxies and galaxy clusters.

Astronomers have mapped thousands of galaxies in three-dimensional space from both the Northern and Southern Hemispheres and have discovered that on large scales the universe is a vast, frothy tangle of galaxy clusters interspersed with voids of seemingly empty space.

As we peer farther into space and further back in time, we still find galaxies. One to two billion years after the Big Bang, astronomers see galaxies shining with the blue light of hot young stars. Even further back, shining like airport beacons from the very edge of the visible universe, astronomers still see lumps of matter — quasars.

The COBE observations, however, show that 300,000 years after the Big Bang, matter and radiation were distributed with variations in intensity of no more than a few parts in 10,000. Prior to that era, the universe was so hot that photons of energy were continually absorbed and re-emitted by matter, preventing stable atoms from forming. No lumps of matter could survive in the turmoil of the early universe. Hence, galaxies must have condensed *after* this epoch, when matter and radiation went their separate ways.

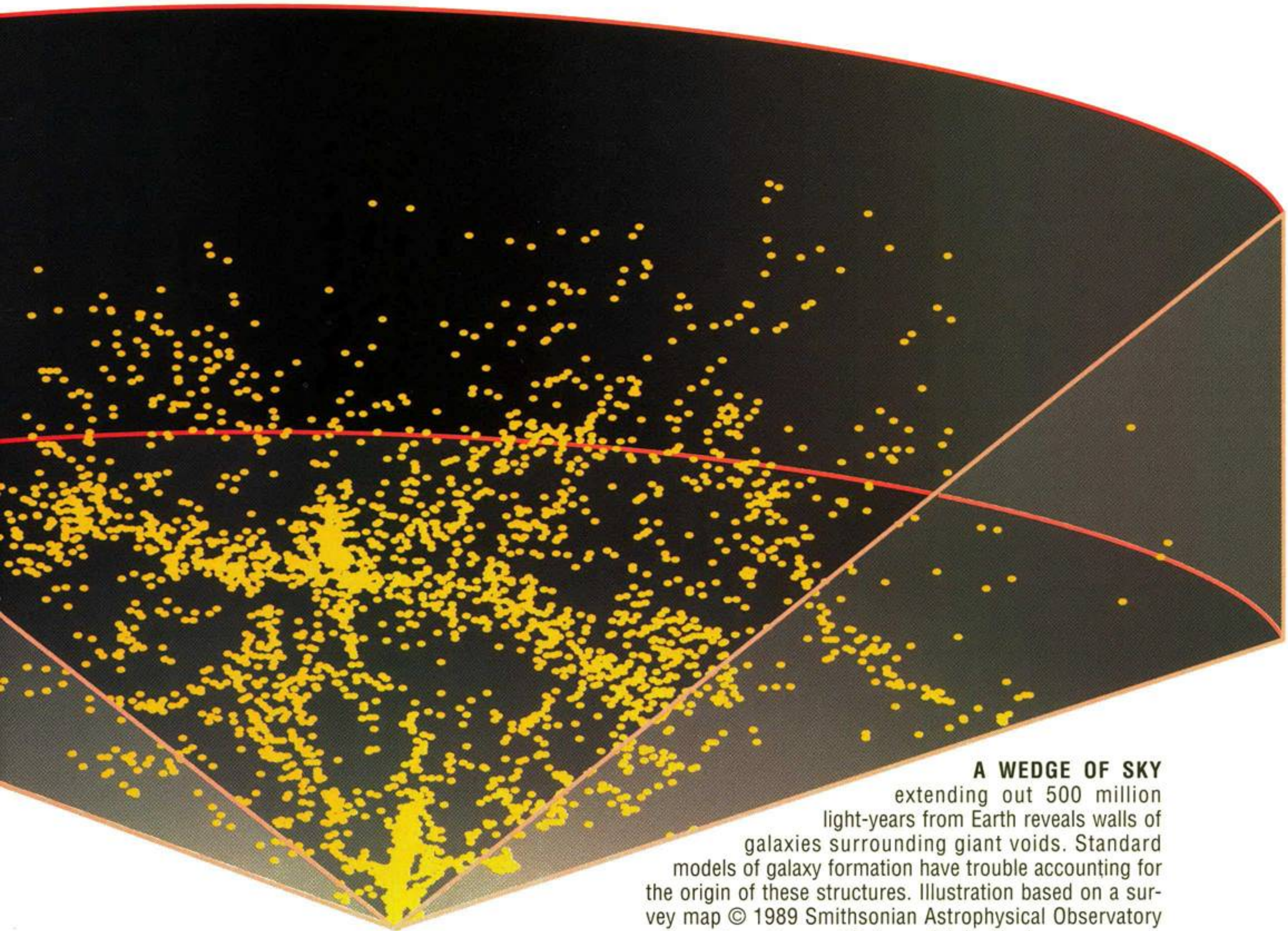
Thus the paradox: Galaxies form in clumps. Yet we know from COBE that the universe started out smooth and featureless. At the present time, astronomers cannot explain how the universe got from one state to the other because there doesn't appear to be enough time between the COBE era and the quasar/galaxy era for gravity to have collected matter into the complex clusters seen today. It is a problem serious enough to prompt a few researchers to suggest there is something wrong with the Big Bang theory.

The Three Pillars of Cosmology

Despite this so-called "structure problem," most astronomers are reluctant to abandon the Big Bang. The evidence supporting the theory, they say, is extensive and compelling enough to stand on its own. Astronomers cite three observations as the underpinnings of the Big Bang cosmology.

The first was made in the 1920s, when astronomers noted that the spectral lines of most galaxies (the lines arising from the emission or absorption of radiation by certain atoms at fixed wavelengths) appeared shifted toward the red end of the spectrum, a shift attributed to the galaxies apparently speeding away from us.

Then, in 1929, American astronomer Edwin Hubble discovered that a galaxy's recession velocity is directly proportional to its distance. Astronomers concluded that the universe is expanding and that



A WEDGE OF SKY extending out 500 million light-years from Earth reveals walls of galaxies surrounding giant voids. Standard models of galaxy formation have trouble accounting for the origin of these structures. Illustration based on a survey map © 1989 Smithsonian Astrophysical Observatory and courtesy Margaret Geller and John Huchra.

space between the galaxies is steadily increasing like the space between raisins in a cinnamon roll as it rises. For the universe to be expanding, however, a propulsive force of unimaginable magnitude — a Big Bang — must have set matter on its runaway course.

The second fundamental observation supporting a Big Bang is the measurement of the total abundance of light elements in the universe. This is akin to analyzing the ingredients of a cake after it's been baked. You know that for the cake to have the consistency, flavor, and structure that it has, certain substances must be present. From an analysis of samples of the cake you can derive a ratio of one ingredient to another, which can then be applied to the entire body of the cake.

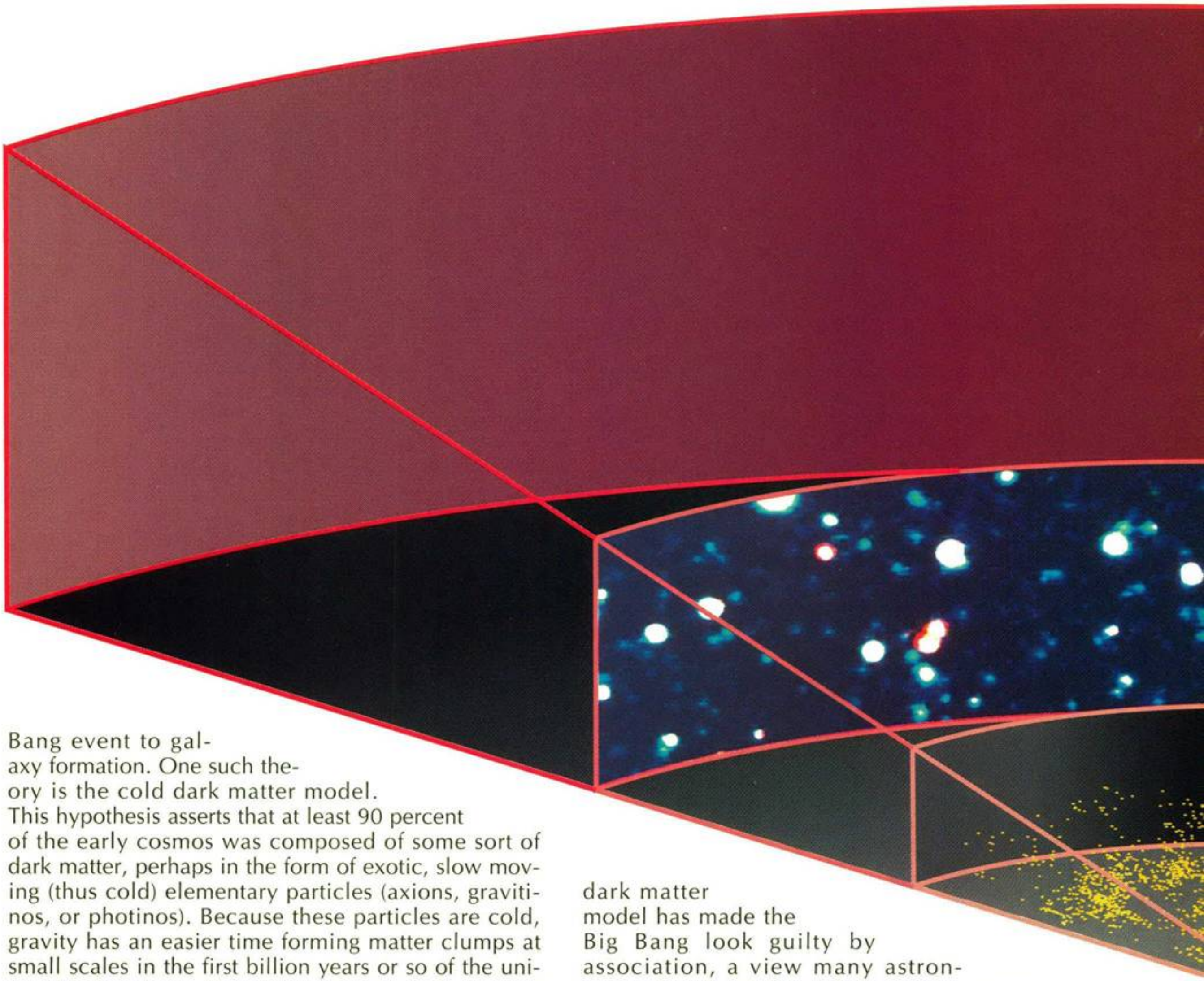
Cosmologically speaking, the elements present in the early universe can be sampled by looking at the most ancient components of the universe — the oldest stars (usually found in globular clusters). The ratio of helium to hydrogen in these stars is exactly what the Big Bang theory predicts should have been forged by thermonuclear reactions 100 seconds after the primordial event. Though scientists have attempted to come up with other theories to account for the light-element abundances, none has accounted for them as well as the Big Bang.

Finally, we return to the cosmic background radiation, considered the most compelling argument for a Big Bang. The cosmic background temperature is 2.7 kelvins, and this radiation is uniform across the entire sky. Nowhere is the temperature higher or lower than this value. Slight variations would indicate hot spots in the background, the lumpy seedlings for the first clusters of galaxies. So far, none have been detected. This is exactly what the Big Bang model predicts.

Cracks in the Pillars?

But it is here that problems arise. For despite the three observational pillars, the Big Bang theory fails to fulfill the requirement for a complete cosmology: it does not explain it *all*. Everything in existence. Everywhere. The Big Bang theory explains only the first few moments of the universe; it stops short of explaining how galaxies and stars materialized in the first one billion years of the universe. This leads to the unsettling conclusion that, though astronomers believe they know how the universe began, they don't know how it got to its present state. Like the missing 18 minutes from the Watergate tapes, there is a narrow but crucial gap in the transcripts of the universe.

Filling the gap requires a theory that links the Big



Bang event to galaxy formation. One such theory is the cold dark matter model. This hypothesis asserts that at least 90 percent of the early cosmos was composed of some sort of dark matter, perhaps in the form of exotic, slow moving (thus cold) elementary particles (axions, gravitinos, or photinos). Because these particles are cold, gravity has an easier time forming matter clumps at small scales in the first billion years or so of the universe. These clumps — estimated to have the mass of a typical globular cluster — gravitationally attract more matter until galaxy-sized masses are built up. The galaxies themselves then collect into the elaborate clusters we see today. This is known as the "bottom-up" model of galaxy formation.

Unfortunately, cold dark matter, exotic or otherwise, has yet to be detected, save indirectly by what are thought to be its gravitational effects on normal matter, specifically the motions of galaxies in clusters and the rotations of spiral galaxies. Astronomers have yet to determine what form this dark matter takes. (See "Shedding Light on Dark Matter," February 1992 ASTRONOMY.)

Compounding the problem, even the most generous cold dark matter models cannot account for the astonishing dimensions of large-scale structures that are turning up in galaxy surveys today — structures that span nearly a billion light-years.

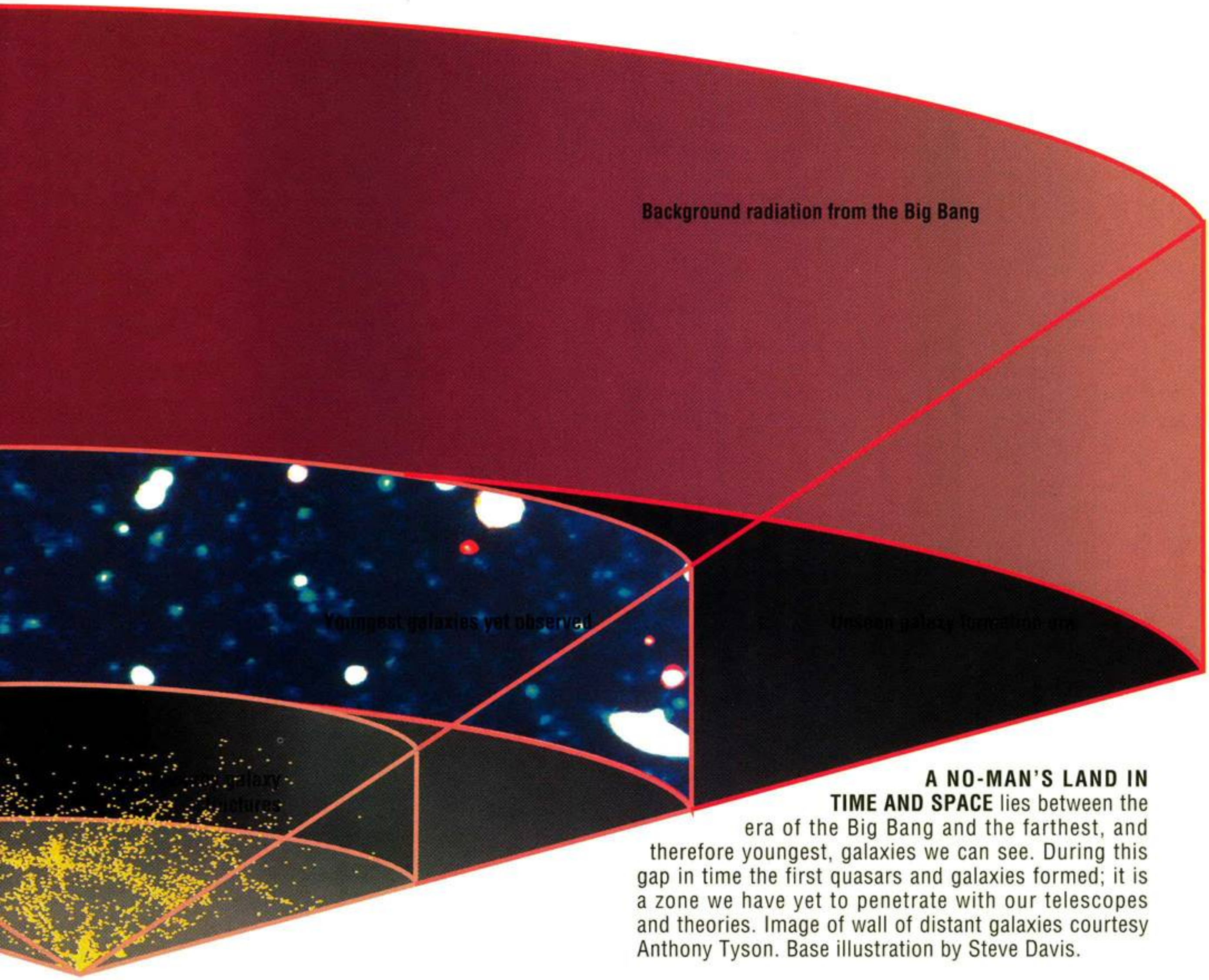
Is the Big Bang in trouble? Most astronomers think not. They view the Big Bang and galaxy formation as separate events. "I don't think anything that's happened recently has changed the majority opinion that the Big Bang is sound," says Ethan Vishniac of the University of Texas at Austin. "I would say the current situation is that we have no believable theory of galaxy formation. What has happened in the last year or so is that . . . the cold dark matter theory has collapsed."

For some astronomers, the downfall of the cold dark matter model has made the Big Bang look guilty by association, a view many astronomers reject. "Cold dark matter is a theory about the beginning of the formation of structure," says Princeton University cosmologist James Peebles. "The Big Bang is something quite different. The problem is that the press has conflated the two. They take the discussions about the beginnings of structure and confuse them with the beginning of the universe."

Taking issue with Vishniac, Peebles, and practically the entire astronomical community is Anthony L. Peratt, a physicist and cosmologist at Los Alamos National Laboratory. Rather than propose a better theory of galaxy formation, Peratt suggests scrapping the Big Bang altogether.

"The Big Bang theorists attempt to decouple themselves from the problem of galaxy formation," says Peratt. "But one must ask what kind of cosmology is it that cannot account for the galaxies and stars we observe? This was a basic requirement for all previous cosmologies, from the time of the Ionians to Newton. Big bang cosmologists have struggled mightily to find a mechanism for galaxy formation in spite of their arguments that this is not their problem."

Peratt belongs to a group of scientists who subscribe to an alternative cosmogenesis theory called "plasma cosmology," which argues that the laws of electromagnetism, rather than gravity, dominate and shape the universe.


Background radiation from the Big Bang
Youngest galaxies yet observed
Unseen galaxy formation era
galaxy structures

A NO-MAN'S LAND IN TIME AND SPACE lies between the era of the Big Bang and the farthest, and therefore youngest, galaxies we can see. During this gap in time the first quasars and galaxies formed; it is a zone we have yet to penetrate with our telescopes and theories. Image of wall of distant galaxies courtesy Anthony Tyson. Base illustration by Steve Davis.

An Alternate Universe

Plasma is a state of matter that resembles a gas, except that instead of consisting of electrically neutral atoms, plasma contains charged particles — electrons torn from atoms in a gas, leaving a cloud of negatively charged free electrons and positively charged ions. Although affected by gravity, these charged particles can also be accelerated by electromagnetic fields.

Most of the visible mass of the universe is plasma. On Earth, the most dramatic forms are lightning and aurorae. In space, stars are gravitationally bound plasmas. On larger scales, plasmas have been detected at the galactic center and in the double lobes of radio galaxies. The largest plasma structure was discovered in 1989, when faint radio emission was detected between two superclusters of galaxies, indicating that the superclusters are embedded in a warm plasma.

The plasma cosmological model was first proposed by Hannes Alfvén, of the Royal Institute of Technology in Stockholm, Sweden. In 1970, Alfvén was awarded the Nobel Prize in physics for his work in solar magnetohydrodynamics — the movement of plasma in magnetic fields. In separate work, Alfvén reasoned that sheets of electric currents crisscross the universe. These electromagnetic fields and not gravity, plasma cosmologists suggest, are the major movers of matter on the grandest scales. Interaction with electromagnetic fields, Peratt says, enables plasmas to exhibit complex structure and motion that far exceed what's possible with gravity alone.

Plasma proponents have conducted computer simulations involving tens of millions of test particles (used to represent galaxies) to demonstrate that a fundamentally uniform plasma will eventually break up into cellular structures that look remarkably similar to the large-scale structures seen today.

The cellular structures would, in turn, act to scatter radiation. Plasma cosmologists theorize that what we detect as the cosmic background actually results when local fields and currents scatter microwave radiation from pervasive plasmas like a dense fog scatters a car's headlights.

But what about the successful prediction of the abundance of light elements proclaimed by Big Bang proponents? "We have always questioned just how well known the abundances of light elements are in the universe," says Peratt. "And if the universe is cellular and filamentary, what are the abundances of the elements within and without the filaments?" Peratt cites a recent measurement of light elements in galaxies that indicates a helium abundance *lower* than that allowed by the standard Big Bang model. A lower assumed density of the universe would produce such a lower helium abundance, but that would also mean the standard Big Bang model does not satisfy the primordial abundance constraints for the other light elements for any density. Interestingly, such low helium abundances were found by other researchers in 1988.

As for the "missing link" between the Big Bang and the first galaxies, plasma physicists claim there is no missing link because there never was a matter-forming epoch. As Peratt writes in an article in the January/February 1990 issue of *The Sciences*, "There is no expansion, and there need not be any final crunch. Unlike the universe envisioned in the Big Bang model, the plasma universe evolves without beginning and without end: it is indefinitely ancient and has an indefinite lifetime in store."

Peratt's plasma cosmology isn't the only alternative idea. The steady state model still has a few supporters. Steady state theorists claim that new galaxies are constantly forming to replace old galaxies at a rate determined by the expansion rate of the universe. Supporters also argue that the cosmic microwave background is actually normal radiation from stars, radiation that has been scattered by metallic "whiskers" sown throughout the interstellar medium in supernovae ejecta.

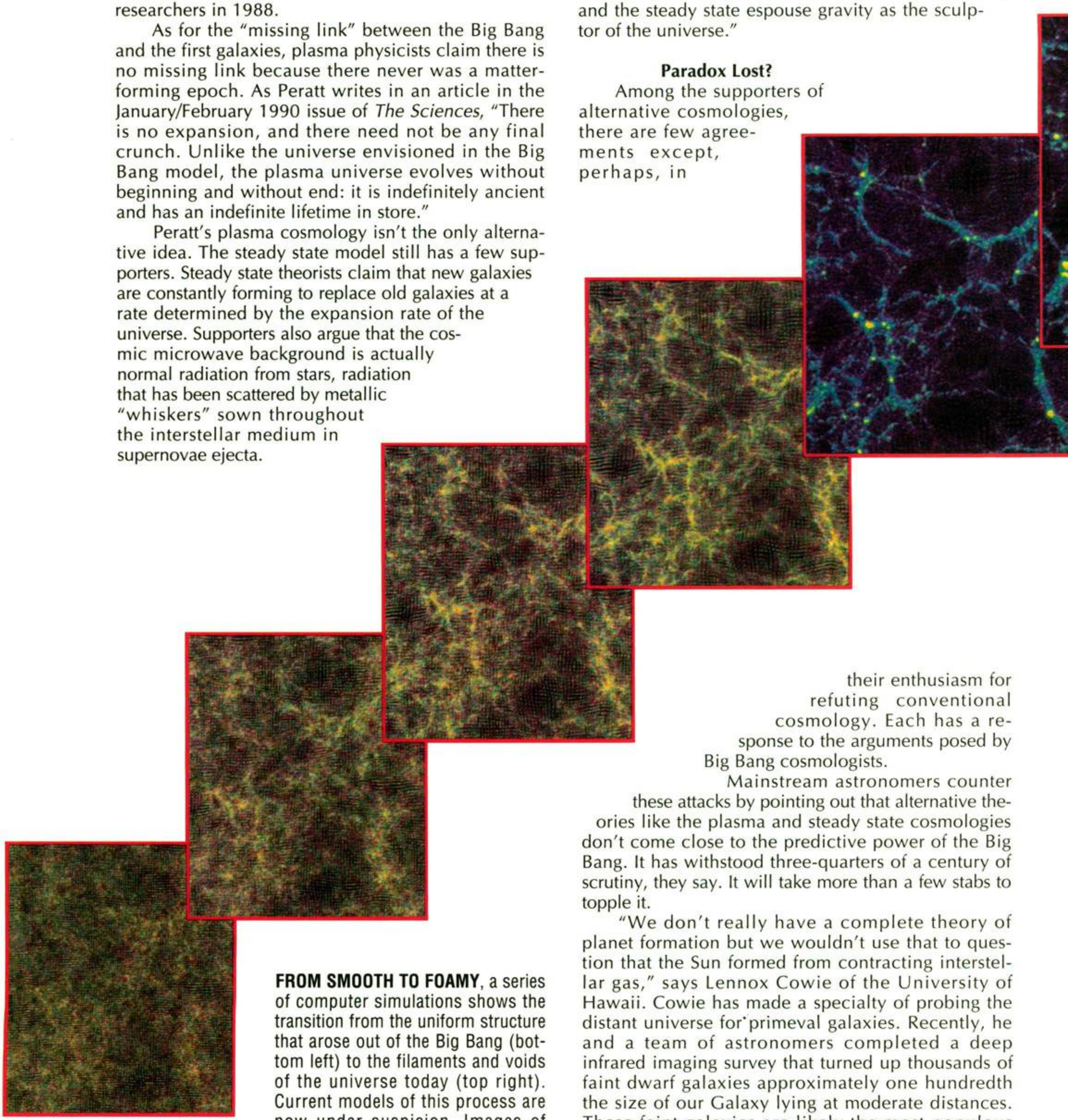
But don't confuse plasma cosmology with steady state theories, explains Peratt. Steady state invokes a perfect cosmological principle in which the universe ap-pears the same at all points at all times — past, present, and future. In contrast, the plasma universe does evolve with time. According to Peratt, "The plasma universe model has nothing to do with the steady state model. Both the Big Bang and the steady state espouse gravity as the sculptor of the universe."

Paradox Lost?

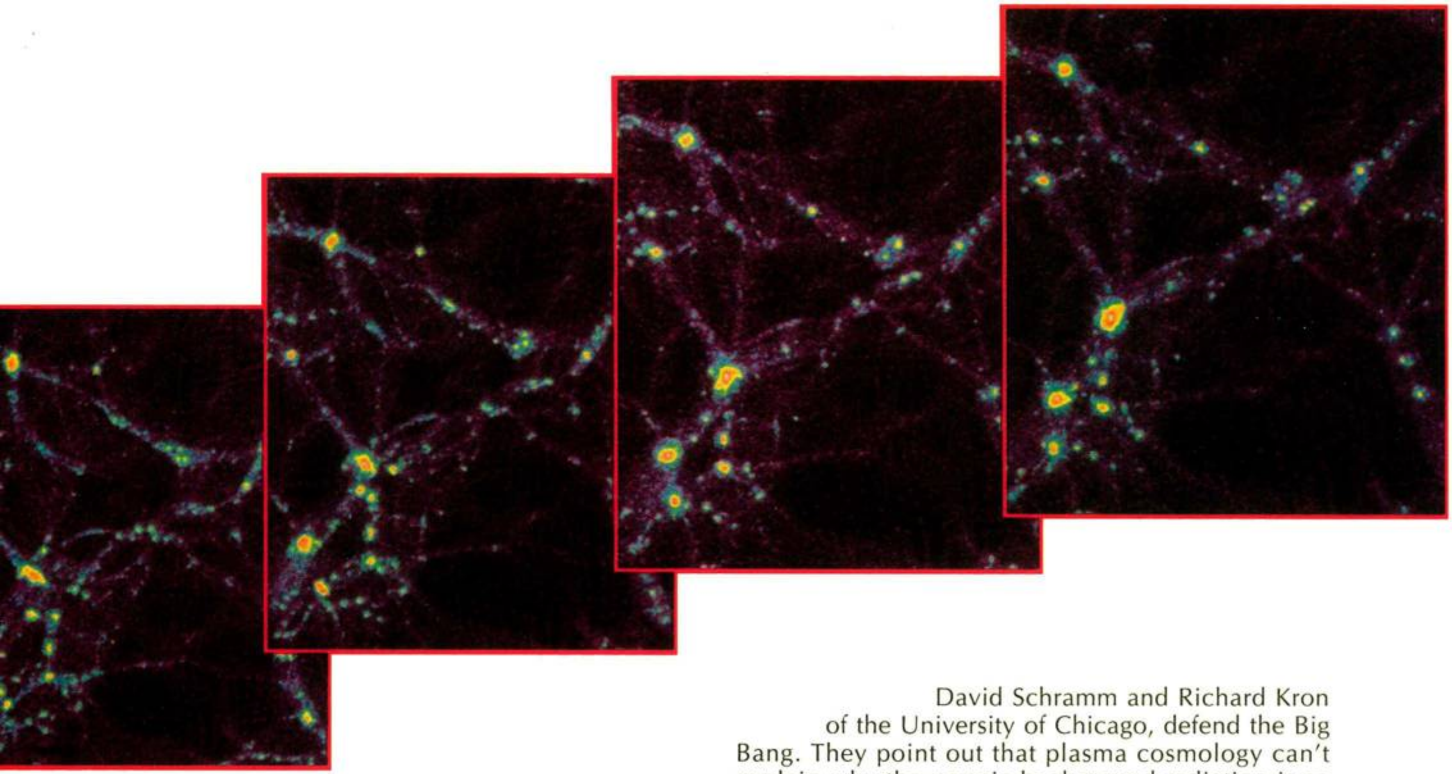
Among the supporters of alternative cosmologies, there are few agreements except, perhaps, in their enthusiasm for refuting conventional cosmology. Each has a response to the arguments posed by Big Bang cosmologists.

Mainstream astronomers counter these attacks by pointing out that alternative theories like the plasma and steady state cosmologies don't come close to the predictive power of the Big Bang. It has withstood three-quarters of a century of scrutiny, they say. It will take more than a few stabs to topple it.

"We don't really have a complete theory of planet formation but we wouldn't use that to question that the Sun formed from contracting interstellar gas," says Lennox Cowie of the University of Hawaii. Cowie has made a specialty of probing the distant universe for primeval galaxies. Recently, he and a team of astronomers completed a deep infrared imaging survey that turned up thousands of faint dwarf galaxies approximately one hundredth the size of our Galaxy lying at moderate distances. These faint galaxies are likely the most populous type of galaxy in the universe. But more importantly, he adds, "They probably contain at least as much



FROM SMOOTH TO FOAMY, a series of computer simulations shows the transition from the uniform structure that arose out of the Big Bang (bottom left) to the filaments and voids of the universe today (top right). Current models of this process are now under suspicion. Images of "cold dark matter" simulation courtesy James Gelb, MIT.



mass as normal galaxies." A universe filled with dwarf galaxies may account for a great deal of the missing mass in the universe, mass predicted by the cold dark matter model. And if you have more mass, you can account for more structure. So perhaps cold dark matter is still lurking out there somewhere, waiting to be found.

The Big Bang theory could also be strengthened by looking at galaxy formation in a new way. In December 1991 a team of radio astronomers at the Very Large Array in New Mexico announced the discovery of a large mass of hydrogen gas near the edge of the observable universe. According to the "top-down" theory of galaxy formation, galaxy clusters formed when giant primordial gas clouds broke apart into smaller gas clouds and not when smaller clouds came together as in the "bottom-up" scenario. A refined top-down idea may explain how large structures can form in a relatively short time span, solving the current problem. The new discovery may be the first evidence for the process.

The bottom line is that the majority of astronomers are reluctant to toss out the Big Bang theory because of an inability to explain how galaxies form. "The problem of galaxy formation is one that depends on rather poorly understood physics and also on some rather shaky assumptions," Cowie says. "The Big Bang theory on the other hand predicts both the light element abundances and the microwave background. I think until we get a much better understanding of the history of galaxy formation it would be very presumptuous to question the underlying cosmological model."

Princeton University's James Peebles agrees. In fact, in a paper published in the August 29, 1991 issue of the British journal *Nature*, Peebles, along with fellow Princeton cosmologist Edwin Turner, and David Schramm and Richard Kron of the University of Chicago, defend the Big Bang. They point out that plasma cosmology can't explain why the cosmic background radiation is so uniform over the entire sky. And that is just one of many problems they see with the alternative cosmologies.

As Peebles puts it, "Time and again people have said, It's difficult to think of a theory of galaxy formation that can be consistent with all observations. So perhaps that difficulty means that the framework within which we're working — the Big Bang — is wrong.' And time and again that inference has been shown to be incorrect.

"By being a little more clever in the invention of theories," Peebles says, "a person can find a way around the problems and continue to look for a way to build within the Big Bang framework."

Peratt, however, remains steadfast. "Plasma cosmologists don't feel we are 'closing in on creation. . . .' In fact, if our findings are anywhere near right, the universe is much bigger and older than previously imagined."

The conflict between the differing views of the universe presents a classic example of an established theory undergoing a revolution. Though the Big Bang model may have endured for 75 years, history is replete with erroneous scientific beliefs that survived centuries, as well as some "crackpot" theories that later became accepted (continental drift, for example).

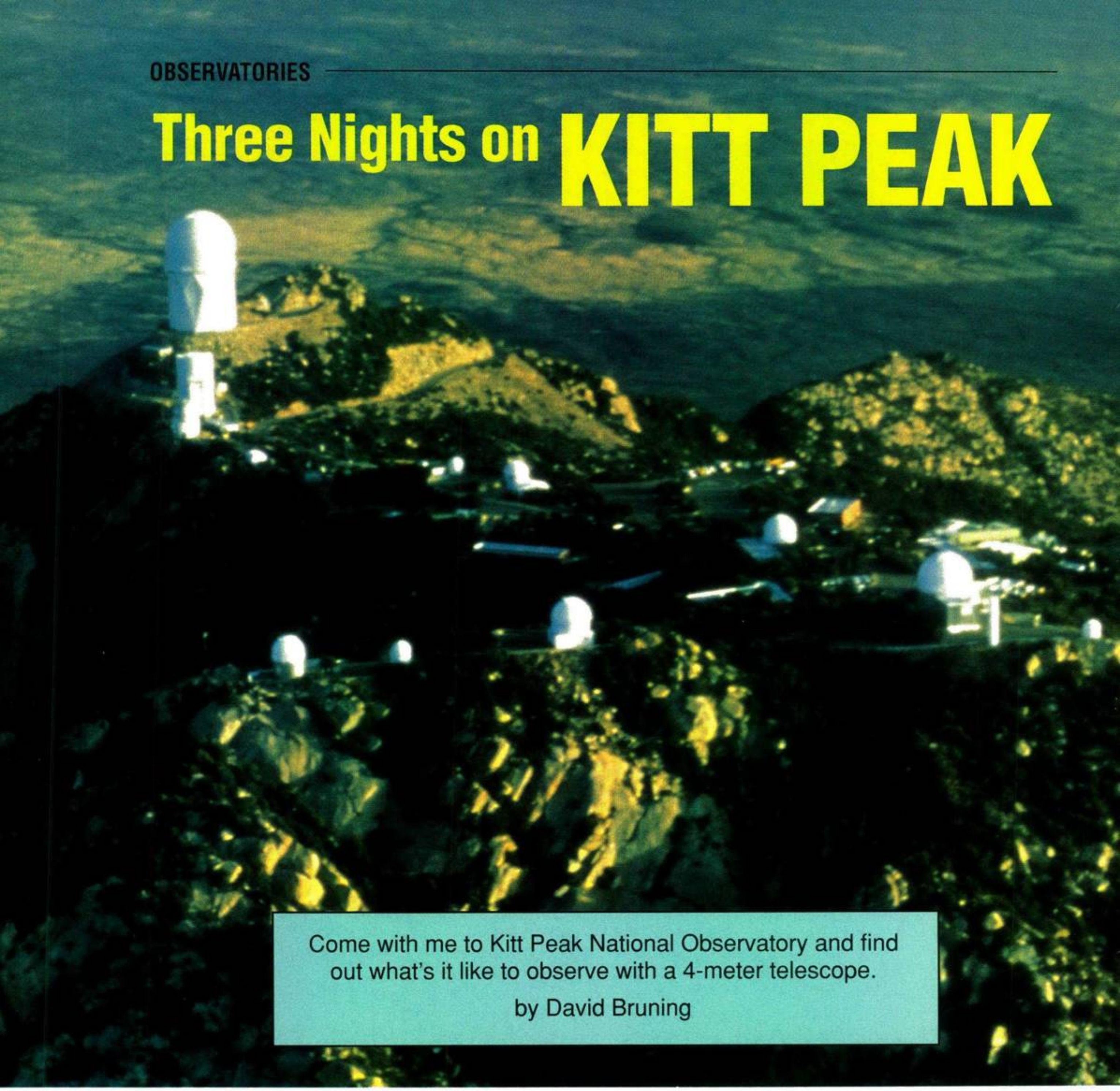
Is the Big Bang theory wrong? It is certainly under attack. Scientists are probing the Achilles' heel of this venerable cosmology in a debate sparked by what new telescopes probing to the edge of the universe have shown us.

But debate is what science thrives on. Without it, we would be like a people starving to death in a land of sacred cows. ☐

Jeff Kanipe, a former associate editor of ASTRONOMY, is now the editor of Star Date *magazine, published by McDonald Observatory and the University of Texas at Austin.*

OBSERVATORIES

Three Nights on KITT PEAK



Come with me to Kitt Peak National Observatory and find out what's it like to observe with a 4-meter telescope.

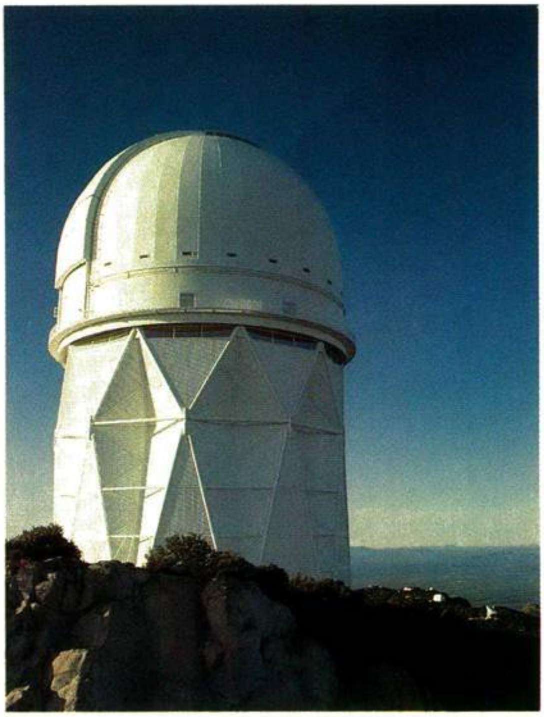
by David Bruning

It's four in the morning and I'm fighting to stay awake. I hope some more hot tea and cookies will help recharge my system sufficiently so I can choose which star gets the honor of the last exposure. This is my third and final night on the Mayall 4-meter telescope on Kitt Peak, outside Tucson, Arizona, and so far it has been the clearest night of the three. I think I'll finally get some good spectra for our white dwarf study.

This observing project is a collaboration among Caty Pilachowski of Kitt Peak National Observatory, Bob Milkey of the Space Telescope Science Institute, and me. Caty and Bob are attending astronomical meetings elsewhere, so one of my contributions to the project is making the observations. Although I'm observing in November, our project got started the previous February when we submitted a proposal to the telescope allocation committee requesting three nights on the 4-meter telescope. We need its light-gathering power to observe our faint white dwarfs. And the 4-meter has a special spectrometer that enables us to measure accurately white dwarf spectra.

We heard in June that we were granted all three nights. I felt quite lucky because most telescopes on Kitt Peak are oversubscribed. For the August 1991 to February 1992 observing semester, only 49 out of 111 proposals were granted time on the 4-meter, so some astronomers will have to reapply next year when their objects are again visible.

The stars we are interested in are called DA white dwarfs.



KITT PEAK'S LARGEST TELESCOPE is the Mayall 4-meter (above). All pictures except at left by the author.

THIS BIRD'S-EYE VIEW of Kitt Peak shows eleven telescopes (left). NOAO 1984 aerial photograph.

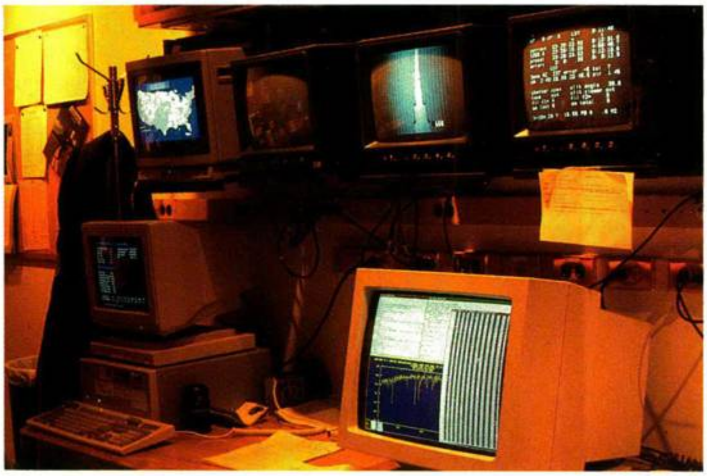
Roughly two-thirds of white dwarfs are of type DA. When the Sun finally uses up its nuclear fuel, it most likely will end its life as this type of white dwarf. The D signifies that the spectrum comes from a degenerate star. (The pressure created by electrons in a special state called degeneracy prevents white dwarfs from collapsing.) The A refers to the fact that only hydrogen lines are visible in the star's spectrum. These stars typically range in temperature from 10,000 to 50,000 kelvins, in mass from 0.2 to 0.9 solar mass, and in radius from 6,000 to 15,000 kilometers. So these stars are hotter than the Sun (5,800 kelvins) but about the size of Earth.

Specifically, our project is to measure how quickly these white dwarfs rotate. During the run, we hope to obtain accurate rotation rates for a few more white dwarfs. We also want to observe several white dwarfs again because their rotation rates are uncertain.

We measure the rotation rate of a white dwarf by analyzing the shape of the red hydrogen-alpha line in the star's spectrum. Preferably, we would like to use more than one line, but DA white dwarfs produce few lines in their spectra (see spectra on page 41). Rotation makes spectral lines broader. By measuring how broad a star's spectral lines are, we can tell how fast the star rotates.

A star like the Sun is considered a slow rotator because it rotates only once every 25 days. But the Sun's rotation rate will become even slower when the Sun runs out of nuclear fuel in its core and expands into a red giant star. Like a figure skater who extends the arms to slow the spin, the Sun will rotate more slowly as a red giant.

But this isn't the final step in the Sun's aging process. After the red giant phase, it will become a white dwarf. To become a white dwarf, the Sun must shrink to about the size of Earth. As it shrinks, it will start spinning faster, like the spinning figure skater pulling in the arms. White dwarfs, from this line of reasoning, should rotate once or twice every minute. However, researchers have found that white dwarfs rotate at a much slower rate — about twice per hour. Why these stars rotate so slowly still puzzles astronomers.



TEN STORIES ABOVE the mountaintop, the 4-meter sits, ready to gather photons from faint, distant objects.

POINTING THE 4-METER is telescope operator Jean Nowakowski's job (top). Weather maps, telescope position, and CCD images surround the astronomer's work station.

If all of the observations from this observing run turn out okay, we'll have spectra for ten stars. Taking spectra of faint white dwarfs is a slow process, even on a 4-meter telescope. In order to measure the spectrum accurately, we must observe each star for two or three hours. The hardest part is staying awake because everything is computer controlled.

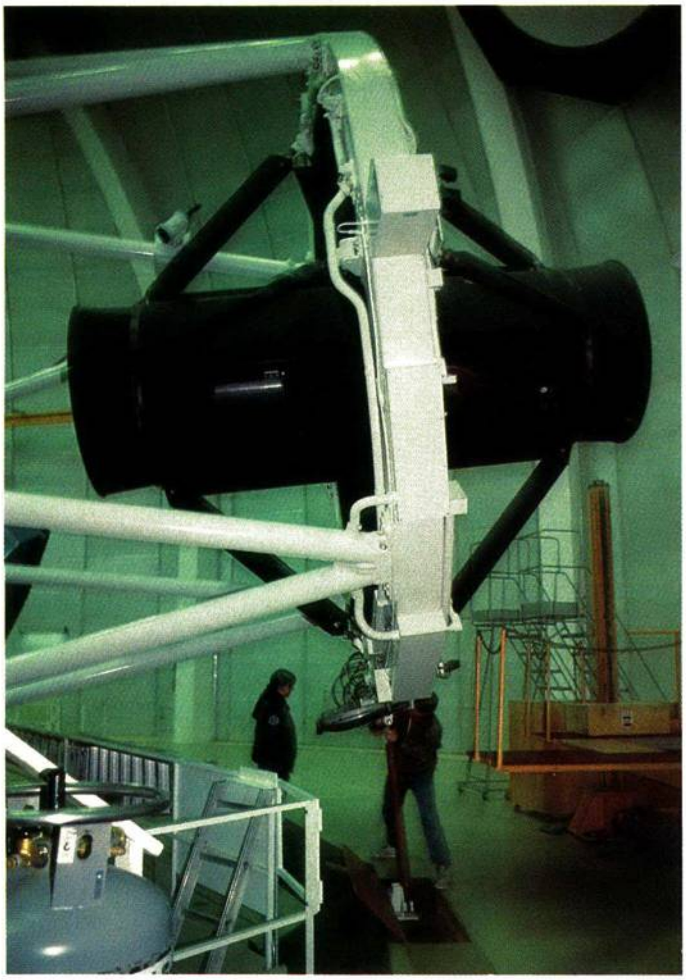
Unlike the "good old days," when the astronomer would ride the Cassegrain cage to guide the star image along the entrance to the spectrometer, we now sit in a warm console room. Computers slew the telescope to the next object, move the dome to follow the telescope, control the CCD camera on the spectrometer, and display the CCD image. Automatic guiders relieve the astronomer of the tedium of guiding the telescope for several hours.

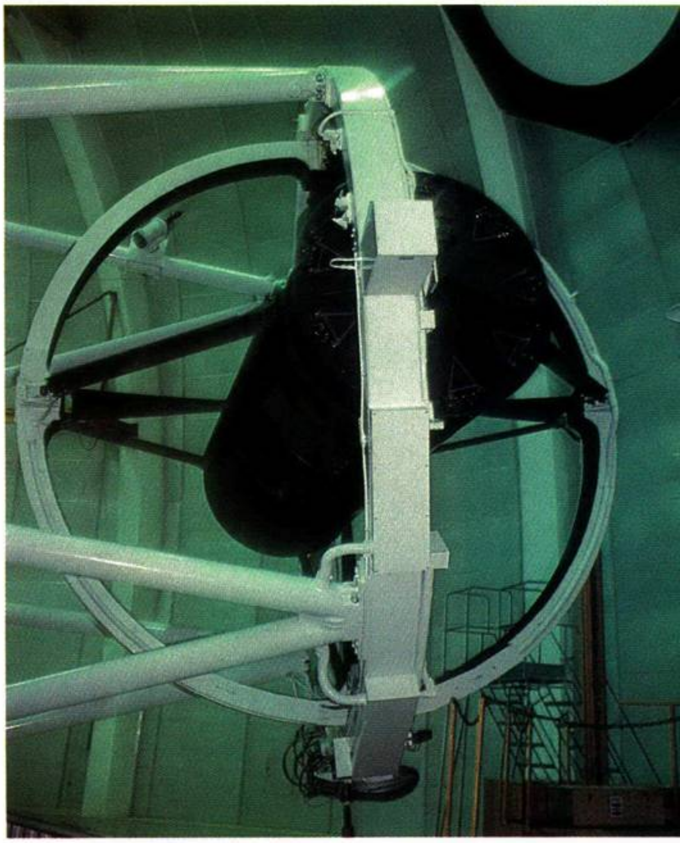
Since computers now do most of the work, the time astronomers used to spend guiding and moving the telescope and dome is now free. On previous observing runs, I tried to read professional journals, but I found the journals to be more powerful than sleeping pills at 2 a.m. Now I mostly read fiction. I actually feel a little extraneous with the computers doing most of the work and can see the day when astronomers will routinely "observe" from their home institutions through a computer link to the observatory.

Even though the job is easier, the work day is still long. This morning I got to bed about 10 a.m. and I was up again at 2 p.m. to sort through my star list for the night's objects. Before dinner at 5 p.m., I started the CCD calibration procedures because we don't want to use valuable observing time on these camera exposures. A quick dinner — or was it breakfast? — and I was back at the telescope as the Sun set.

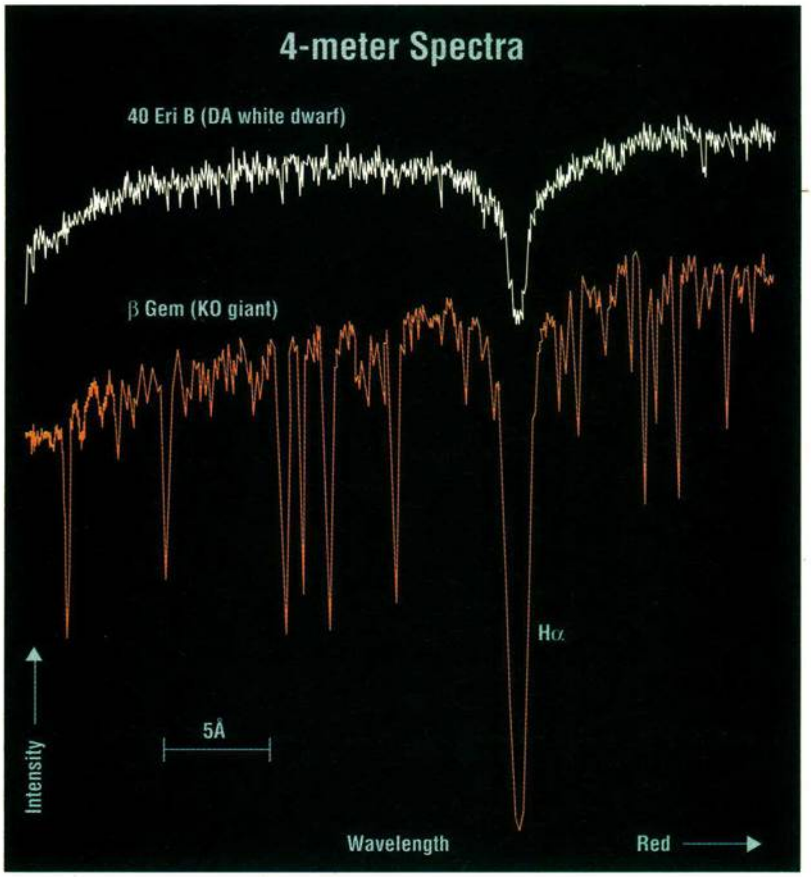
Astronomers don't get to move the telescope. Large telescope operators (LTOs) are assigned to assist astronomers on the large scopes at Kitt Peak. They decide if the telescope should be closed because of the weather and they move the telescope and dome for the observer. The LTOs also help with instrument and computer problems. They are an indispensable part of the observing team and often don't get the recognition they deserve for making the observing run successful.

Finally deciding on a white dwarf called EG46 as the last star to observe, I hand the star's coordinates to Dave Chamberlin, my LTO this night. He types them into the telescope control computer and the 4-meter moves to the first star. The pointing on this telescope is so accurate that the star arrives almost directly on the entrance aperture of the spectrometer. Dave sets the automatic guider and I start the exposure.





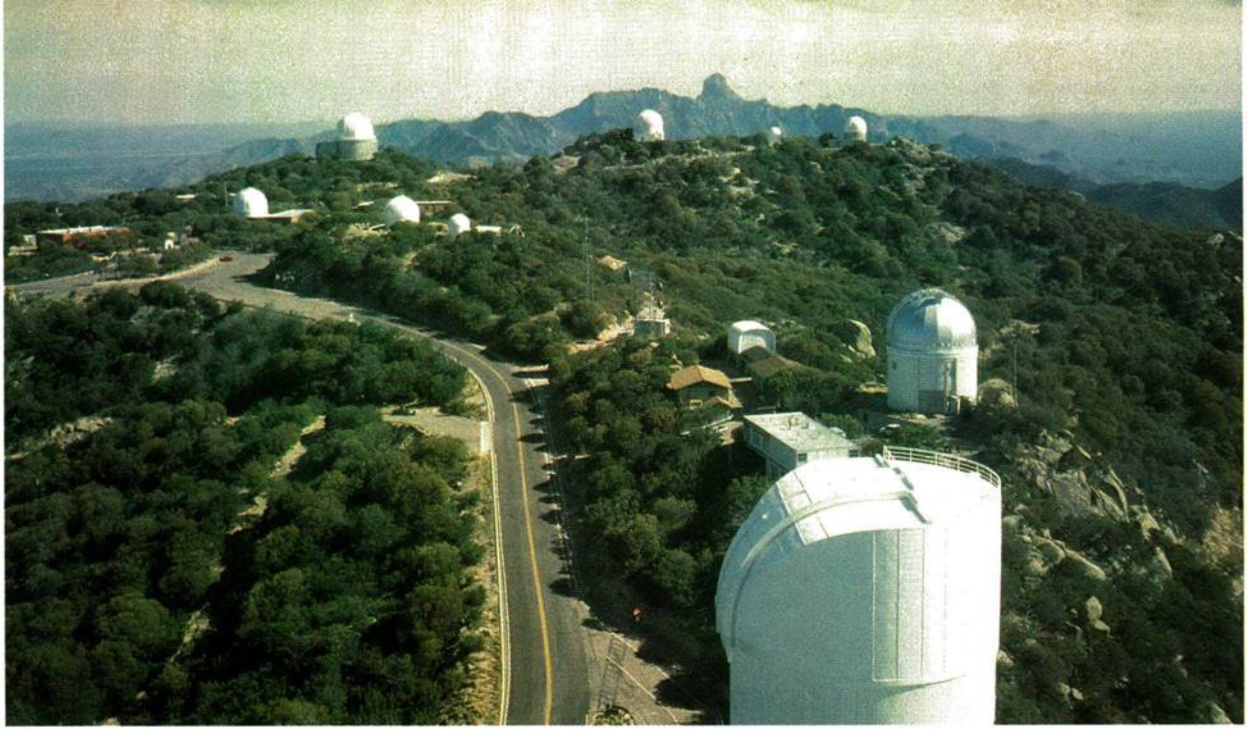
SWINGING THE 4-METER'S CAGE changes where the telescope focuses light (above left and top). White dwarf spectra (below) look less complicated than spectra of normal stars.



I don't have to make any adjustments to the spectrometer thanks to another key member of the observatory staff, Darryl Willmarth. Darryl was the support scientist assigned to help set up the instrument used during my run. He showed me how to use the spectrometer and the new computer system. These kind, helpful support scientists are often wakened by grumpy astronomers whose research is temporarily stymied by some problem. I'm thankful I haven't had to call Darryl at all during this run since the instrument has worked smoothly.

I wish I could say the same about the weather. The first night of our run was cloudy and windy. Jean Nowakowski was my LTO then and she kept a watchful eye on the weather. If the humidity gets too high or the wind speed creeps over 45 miles per hour, the telescope must be closed. The wind had been brisk and we worried more than once that we might have to close. Fortunately, the wind kept below 35 miles per hour.

The wind can play interesting tricks on you around the telescopes. Somehow the one door at



STEWARD OBSERVATORY appears in the foreground in this view from the 4-meter (above). Two radio telescopes and the McGraw-Hill Observatory are on a nearby ridge (left).

the base of the 4-meter building always managed to rattle just after I walked by it. At least it wasn't as eerie as the McMath solar telescope used to be before the wind screen was installed. When the wind blew across the top of the McMath, it was like air sounding an organ pipe. The telescope would moan and howl like a lost soul.

Of course, the 4-meter has its own tricks. When the dome rotates, the floor trembles slightly as if a mild earthquake has struck the mountain. The telescope is mounted on a pier that is separate from the dome support, so it doesn't feel the dome movement. But unsuspecting, dozing astronomers have sometimes been awakened by the tremor.

The unstable atmospheric conditions that night also affected the seeing. Star images were over 4 arcseconds in diameter. This was disastrous for our observations because it meant very little star light entered the spectrometer. The already faint white dwarfs appeared more than one magnitude fainter. Also, the humid air caused clouds to form directly overhead. We fought a grim duel with the clouds, opening and closing the dome, until the clouds dispersed after midnight.

Jean's job started at sunset when she first opened the dome to equalize the temperature of the air inside and outside the dome to optimize the seeing. Sunset was spectacular, thanks to the dust cloud from the Mount Pinatubo eruption. While we waited for the sky to get dark, we took some calibration frames for the CCD camera. Jean's job didn't end at sunrise, because another astronomer, Ken Hinkle, came on duty to observe for a few hours after daybreak.

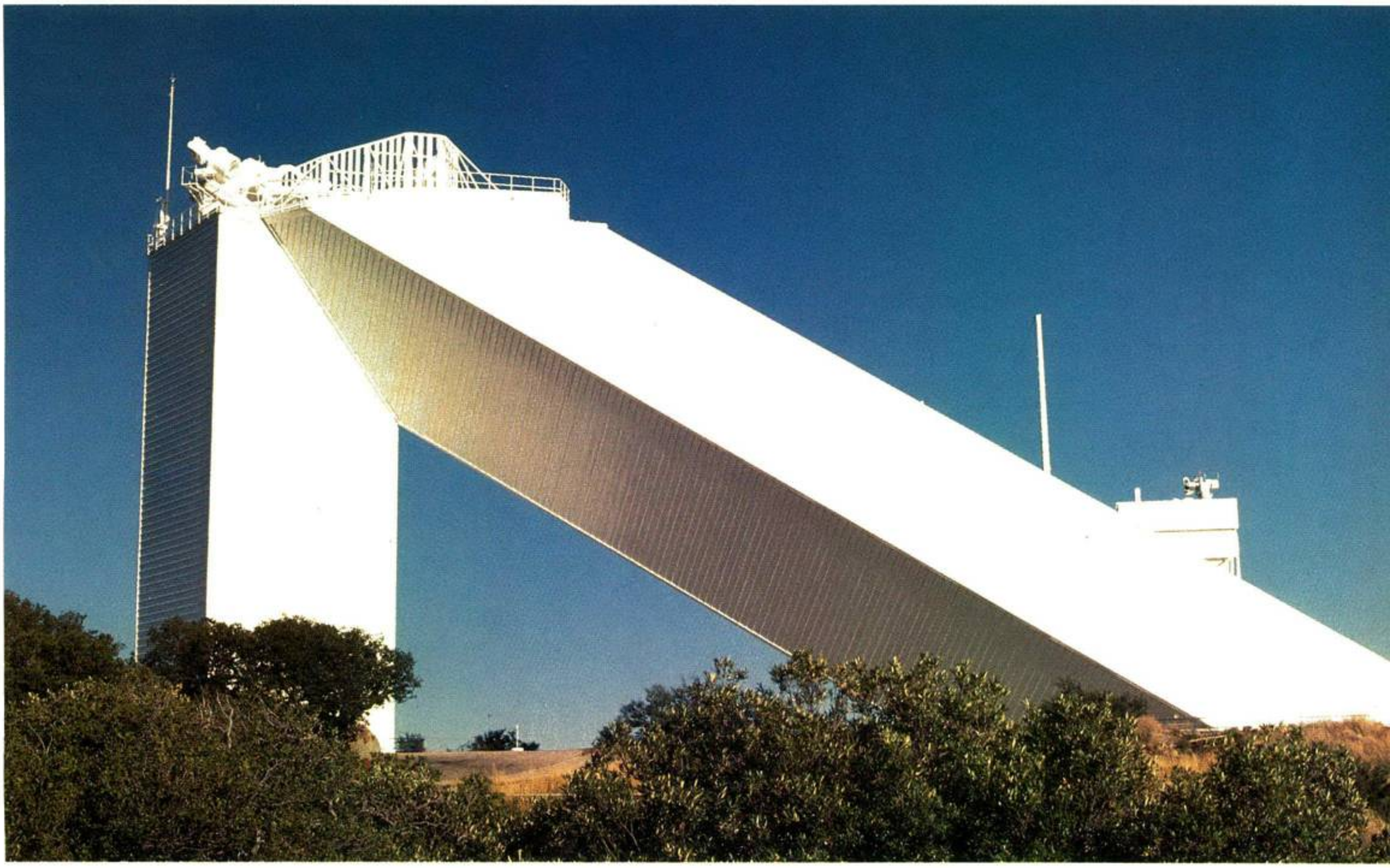
Jean then helped Alex Macdonald, the LTO who assisted Ken, to rotate the cage at the front end of the telescope. The cage holds two secondary mirrors back-to-back. My program uses the Cassegrain secondary because the spectrometer is mounted at the back-end of the telescope. Ken's program uses another spectrometer mounted two floors below the telescope, so the coudé secondary must be used to focus light at his instrument.

Ken is an infrared astronomer and was looking at IRC +10216, a carbon star that is obscured by a circumstellar shell. He aimed to find the relative abundance of hydrogen to carbon for this object. Astronomers need this ratio to estimate how much mass is lost each year by IRC +10216. Ken can observe during the day because Earth's atmosphere is relatively dark in the infrared.

Jean was again my LTO on the second night. The wind and poor seeing continued, so the spectra did not look very good. I worried greatly that the entire observing run would be a wasted effort. If we didn't get data from this run, it would be several years before we again were on the 4-meter. Sometime during the night, someone called with a report of a bright meteor that had streaked across the sky. Unfortunately, we were in a closed room and didn't see anything. Alex joined us again the next morning when Ken returned for another morning of observing.

Finally, on this last night of my run, the wind died down and the seeing got a little better. It's not great at 2 arcseconds, but one gets more light into the spectrometer and better spectra. Observing went so much better that Dave worked through his normal midnight lunch time and I skipped lunch altogether.

Although many large telescopes are being built on Mauna Kea in Hawaii, Kitt Peak still has the single largest collection of telescopes in



the world, with new additions planned. The University of Wisconsin, Indiana University, Yale University, and the National Optical Astronomy Observatories (NOAO, Kitt Peak's parent organization) have joined to build the 3.5-meter WIYN telescope at the site where a 0.9-meter telescope resided for many years (bottom left of photograph on page 38).

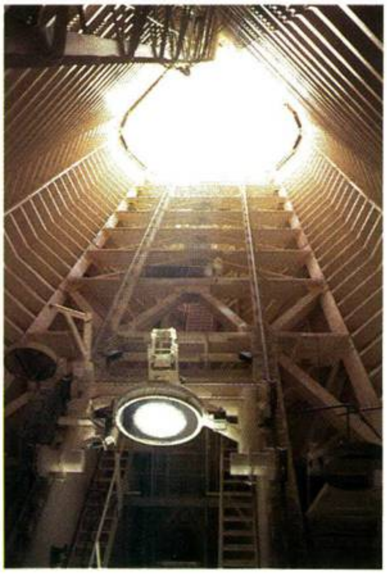
The National Radio Astronomy Observatory operates two telescopes on a ridge to the west of the Kitt Peak observatory site. Case Western Reserve runs a Schmidt camera on the mountain, and the University of Arizona has several telescopes, including those of Steward Observatory (2.3 meters) and the Spacewatch program (0.9 meter). McGraw-Hill Observatory, operated by the University of Michigan, MIT and Dartmouth College, has 1.3- and 2.4-meter telescopes.

Another branch of NOAO, the National Solar Observatory, has its McMath and vacuum telescopes on the mountain. Although originally used almost exclusively for solar observations, the McMath also has an active laboratory spectroscopy program and a vigorous nighttime stellar observing program. Astronomers currently are exploring the feasibility of upgrading the McMath's 1.5-meter optics to 4 meters. Larger mirrors would enhance solar observations in the infrared and the nighttime programs.

Even the visitor center is being upgraded. Visitors may tour the observatory from 9 a.m. to 3:45 p.m. every day, except Thanksgiving Day, December 24 and 25, and New Year's Day. Be aware that the observatory is at an altitude of nearly 7,000 feet and that you'll need to walk a lot to tour the telescopes. Also note that the weather on the mountain may be considerably cooler than that in Tucson. I always like to stop in the visitor center to admire the basketry of the Tohono O'odham Indians, who own the land upon which the observatory sits.

Now it's 6 a.m. and the end of my observing run. If this were a novel, I would be driving back to Tucson as the Sun rises. Instead, I still have several hours of work to do, copying our hard-won data to magnetic tape and making copies of the observing logbook. As the data flow silently onto the tape, I wonder whether the observing run has been a success. Unfortunately, we won't know until we analyze the data. But with any luck, we'll have gained new knowledge about the rotation of white dwarfs — and *maybe*, with an extra bit of luck, we'll learn a little more about how stars evolve from giants into white dwarfs. ☐

SUNLIGHT REFLECTS off the McMath telescope's upper mirror (above), down a shaft cut in the mountain. Another mirror (right) bounces focused light into the observing room.



CELESTRON *Dealers Support* C8's

These Celestron dealers proudly display a combination of C8 models in their stores.
In cases where a retailer has multiple outlets, only the headquarter's location is listed.

ALASKA

Stewart's Photo
Anchorage, AK
(907) 272-8581

ALABAMA

John's Photo & Video
Birmingham, AL
(205) 251-1600

Perry Color & Camera Inc.
Birmingham, AL
(205) 251-2507

ARIZONA

Guild Camera Shop
Phoenix, AZ
(602) 264-5808

Wilson Camera Sales
Phoenix, AZ
(602) 955-6773

Nuart Photo Service
Tucson, AZ
(602) 326-9606

Stellar Vision
Tucson, AZ
(602) 571-0877

CALIFORNIA

Claremont Camera
Claremont, CA
(714) 626-2219

Empire Camera
Colton, CA
(714) 825-8922

Basic Living Products Inc.
Emeryville, CA
(415) 428-1600

Boot's Camera Corp.
Fresno, CA
(209) 432-0446

Tony Rose Camera
Goleta, CA
(805) 967-5621

Lumicon
Livermore, CA
(415) 447-9570

Out Of This World
Mendocino, CA
(707) 937-3335

Consumer Scientific Inc.
Mountain View, CA
(415) 967-5515

Los Angeles Optical Company
North Hollywood, CA
(818) 762-2206

Optica B/C
Oakland, CA
(415) 530-1234

Oceanside Photo Center
Oceanside, CA
(619) 722-3343

Star Quest Enterprises
Orange, CA
(714) 633-8505

Odd Assortment
Pacheco, CA
(415) 228-4180

Camera Exchange
Palm Springs, CA
(619) 320-6847

Rocklin Ace Hardware
Rocklin, CA
(916) 632-1196

Orion Telescope Center
Santa Cruz, CA
(408) 464-0446

Miko Photo & Sound Co.
Santa Monica, CA
(310) 393-9371

Scope City
Simi Valley, CA
(805) 522-6646

Woodland Hills Camera
Woodland Hills, CA
(818) 347-2270

COLORADO

Mike's Camera
Boulder, CO
(303) 443-1715

Denver Museum of
Natural History
Denver, CO
(303) 370-6324

S & S Optika Ltd.
Englewood, CO
(303) 789-1089

CONNECTICUT

Pauli's Discount Optics
Danbury, CT
(203) 746-3579

FLORIDA

Jim's Photo Shack
Clearwater, FL
(813) 536-9661

Phil's Camera Service
Miami, FL
(305) 238-7842

Colonial Photo & Hobby
Orlando, FL
(407) 841-1485

Sarasota Camera Exchange
Sarasota, FL
(813) 366-7484

GEORGIA

Camera Bug
Atlanta, GA
(404) 873-4513

HAWAII

Francis Camera Shop
Honolulu, HI
(808) 946-2879

ILLINOIS

Adler Planetarium Store
Chicago, IL
(312) 322-0312

American Science Center
Chicago, IL
(312) 763-0313

Shutan Camera Company
Chicago, IL
(312) 332-2000

INDIANA

Dill Camera Shop
Mishawaka, IN
(219) 255-6285

KANSAS

Science Education Center
Wichita, KS
(316) 682-1921

LOUISIANA

EP Roberts Instruments
Metaire, LA
(504) 834-4078

MARYLAND

Astro World Telescopes
Baltimore, MD
(301) 483-5100

Company Seven
Laurel, MD
(301) 953-2000

MASSACHUSETTS

F.C. Meichsner, Co.
Boston, MA
(617) 426-7092

Harvard Camera Center
Harvard, MA
(508) 456-8100

MICHIGAN

City Camera
Dearborn, MI
(313) 846-3922

Capitol Cities Hobby
Flint, MI
(313) 234-4051

Rider's Hobby Shop
Kalamazoo, MI
(616) 349-2666

Camera Mart, Inc.
Pontiac, MI
(313) 334-9567

Feldman Camera Exchange
Wyandotte, MI
(313) 284-7244

MINNESOTA

National Camera Exchange
Golden Valley, MN
(612) 546-6831

E & W Optical
Minneapolis, MN
(612) 331-1187

NEVADA

Fleischmann Planetarium
Reno, NV
(702) 784-4812

NEW HAMPSHIRE

Rivers Camera Shop
Dover, NH
(603) 742-4888

NEW JERSEY

Photo Center of New Jersey
Bricktown, NJ
(908) 840-1333

Jersey Camera
Clifton, NJ
(201) 742-1295

Dover Photo Supply
Dover, NJ
(201) 366-0994

Roger Tuthill, Inc.
Mountainside, NJ
(908) 232-1786

Bergen County Camera Inc.
Westwood, NJ
(201) 664-4113

NEW MEXICO

Kurt's Camera Corral Inc.
Albuquerque, NM
(505) 266-7766

Photo Supply
Santa Fe, NM
(505) 982-2585

NEW YORK

Berger Bros. Camera
Exchange
Amityville, NY
(516) 264-4160

Focus Camera
Brooklyn, NY
(718) 436-6262

Stangert Corp.
Island Park, NY
(516) 432-4277

Adorama
New York, NY
(212) 741-0052

Clairmont-Nichols Optical
New York, NY
(212) 758-2346

NORTH CAROLINA

Photo Quick One Hour
Asheville, NC
(704) 667-8342

Camera Corner Inc.
Burlington, NC
(919) 228-0251

Carolina Camera Center
Greensboro, NC
(919) 292-2622

OHIO

Eastern Hills Camera
Cincinnati, OH
(513) 271-3803

Eye 1
Yellow Springs, OH
(513) 767-7087

OKLAHOMA

Scope Source
Ardmore, OK
(405) 226-3068

Ad-Libs Astronomics
Norman, OK
(405) 364-0858

OREGON

France Photo
Eugene, OR
(503) 343-2816

Oregon Museum of Science
Portland, OR
(503) 222-2828

PENNSYLVANIA

Cutler Camera & Hi-Fi
Horsham, PA
(215) 674-5727

TEXAS

Whole Earth Provision
Company
Austin, TX
(512) 478-1577

Cooter's Village
Camera Shop
Dallas, TX
(214) 521-4553

Bill Weaver Sporting Goods
Ft. Worth, TX
(817) 731-0804

Analytical Scientific
Helotes, TX
(512) 684-7373

Land, Sea & Sky
Houston, TX
(713) 529-3551

Z Optical Shop
Stafford, TX
(713) 499-4993

UTAH

Hammond Hobby
Salt Lake City, UT
(801) 278-0157

VIRGINIA

Redlich Optical
Falls Church, VA
(703) 241-4077

WASHINGTON

Dick's Camera and Sound
Seattle, WA
(206) 244-1101

WISCONSIN

Wild Birds Unlimited
Madison, WI
(608) 271-2444

WEST VIRGINIA

Merrill Photo Supply Co.
Charleston, WV
(304) 343-0141

CANADA

Alberta

Quasar Optics
Calgary, Alberta
(403) 240-0680

Science Magic
Edmonton, Alberta
(403) 451-6516

British Columbia

CLA Contact Lens Tech.
Port Coquitam, BC
(604) 944-0600

Vancouver Telescope Center
Vancouver, BC
(604) 738-5717

Manitoba

Cosmic Connection
Brandon, Manitoba
(204) 727-3111

Ontario

Scope Shop
Islington, Ontario
(416) 232-1609

Focus Scientific
Ottawa, Ontario
(613) 236-7767

Perceptor
Schomberg, Ontario
(416) 939-2313

Eftonscience
Toronto, Ontario
(416) 787-4581

Khan Scope Center
Toronto, Ontario
(416) 783-4140

Science City
Toronto, Ontario
(416) 968-2627

Quebec

Harrison Co.
Montreal, Quebec
(514) 842-1911

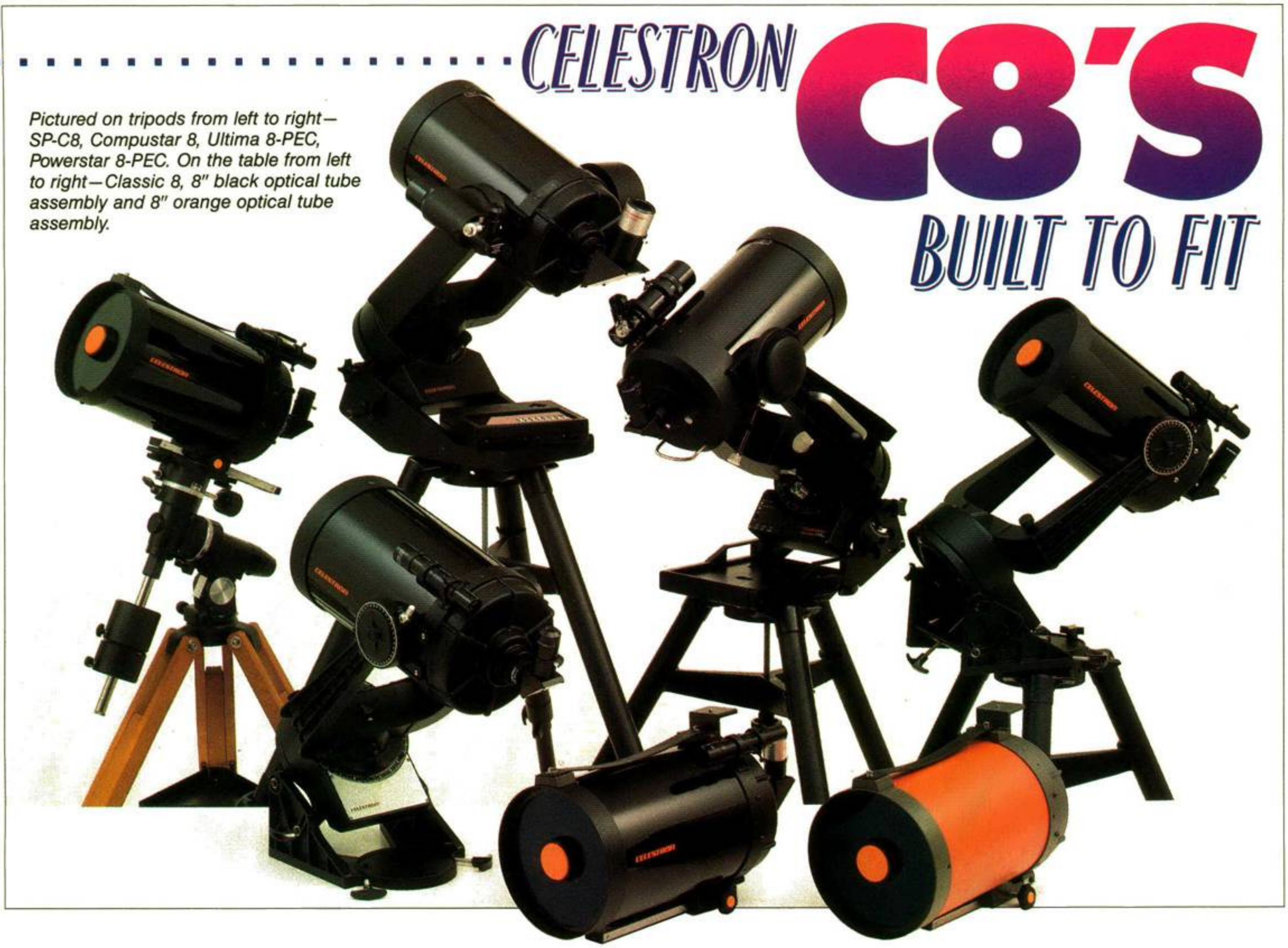
CELESTRON®
Celestron International

**2835 Columbia Street
Torrance, California 90503, U.S.A.
310/328-9560 800/421-1526
FAX: 310/212-5835**

Many other Celestron dealers also feature C8's. Call Celestron for the complete listing of dealers in your area.

CELESTRON C8'S BUILT TO FIT

Pictured on tripods from left to right—SP-C8, Compustar 8, Ultima 8-PEC, Powerstar 8-PEC. On the table from left to right—Classic 8, 8" black optical tube assembly and 8" orange optical tube assembly.



Since 1970, Celestron's 8-inch Schmidt-Cassegrains have continued to grow in popularity. They have become so popular, that a whole family of C8's has evolved. We've built them to fit different tastes, different needs and different budgets.

But all are built with Celestron's same dedication to providing the *finest quality available.* Quality evidenced in the optics (judged best in magazine comparison studies), the sturdy mechanics and the extensive array of optional accessories.

All of our C8's share the same American-made f/10 optical system. For a dual f/6.3, f/10 system, add Celestron's new reducer/corrector accessory. Starbright® optical coatings are standard on all C8's (optional on Super Polaris C8). And all carry a **limited lifetime warranty.**

CLASSIC 8

For the budget conscious, we offer the Classic 8. Supplied with a standard wedge, it works well on a sturdy table. An optional tripod is available but not mandatory. Runs off AC power. Spur gear system.

SUPER POLARIS C8

Another economical choice, this C8 is supplied on a Super Polaris equatorial mount and includes an adjustable wood tripod. This deluxe German mount utilizes 144 tooth lapped worm gears and features a built-in illuminated polar alignment scope. Available with standard coatings or with Starbright® coatings.

POWERSTAR® 8-PEC

A popular intermediate scope, this C8 features a totally cordless DC Servo quartz drive system with Periodic Error Correction.

ULTIMA® 8-PEC

Celestron's premiere 8″ scope, this C8 is ideal for astrophotography. Rugged, highly damped mount, beefy forks. Totally cordless DC Servo quartz drive system with Periodic Error Correction. Long list of upgraded accessories included as standard features.

COMPUSTAR 8

For seasoned observers, a chance to see more. For novices, a help in finding objects. For educators, the ultimate teaching tool. Explore over 8000 objects contained in this C8's microcomputer memory. Totally integrated system with unlimited possibilities. Includes 2″ accessories.

Come in and see for yourself the full family of C8's at a Celestron dealer near you.

CELESTRON®
Celestron International
2835 Columbia Street
Torrance, California 90503, U.S.A.
310/328-9560 800/421-1526
FAX: 310/212-5835

MYSTERIOUS SUNGRAZERS

Silent invaders are playing havoc with our solar system. Right now great and mysterious denizens of the deep — frozen clumps of ice, dust, and rock — may be slamming into the Sun, exploding in a cascade that will end the invader's life.

The peculiar mystery associated with these invaders exists because they sneak in from behind the Sun, so the Sun's light makes it difficult to detect them. Called sungrazers, these impressive comets have only recently been photographed and analyzed. Moreover, they are at the heart of an astronomical detective story that stretches back into ancient history. To understand the full ramifications of these silent inhabitants of the solar system, we must go back more than a decade and sift through the evidence that surprised and delighted the astronomers who collected it.

A Mission for Sungrazers

On August 30, 1979, SOLWIND, a Naval Research Laboratory coronagraph launched with the air force's P78-1 space test program satellite, photographed a small comet just before it disappeared into the Sun. Subsequently dubbed SOLWIND 1, the comet produced a spectacular show as it vaporized. Its remains brightened more than half the Sun's disk for over a full day. SOLWIND found five more comets, all members of a family known as the sungrazers, although they did very little grazing. In fact, none of them survived their encounter with our star.

In 1984 the coronagraph onboard the Solar Maximum Mission (SMM) spacecraft spotted SOLWIND 5 and then took over the role of discoverer. It proceeded to photograph, all by accident, ten more sungrazers in the next five years. Bob MacQueen and Chris St. Cyr, then of the High Altitude Observatory (HAO), published a report on these sungrazing comets. Their data have been useful to Brian Marsden of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, who has traced the lineage of the SOLWIND and SMM comets all the way back to the Stone Age.

The Nature of Sungrazers

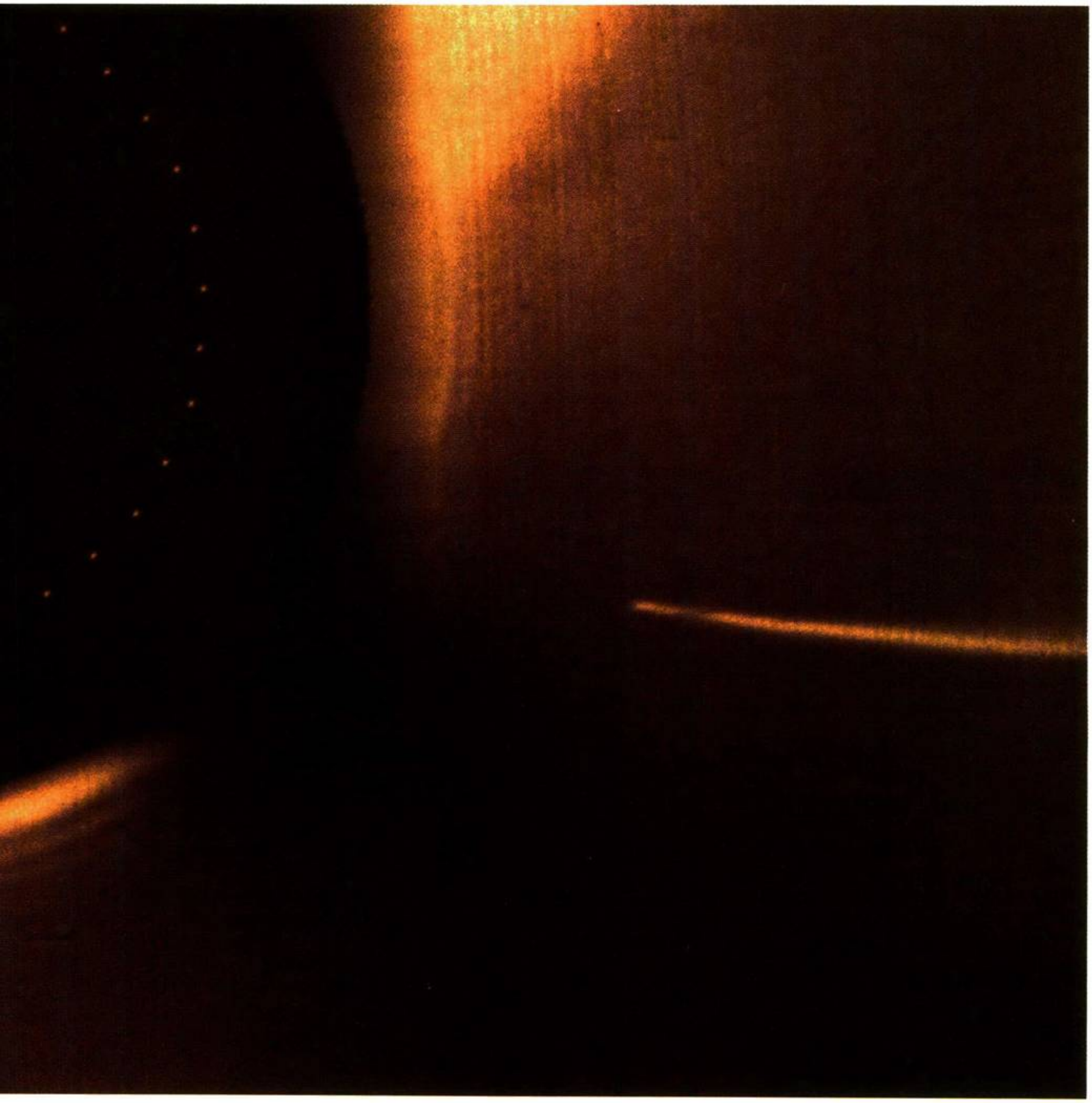
Just what are these sungrazing comets? They are a peculiar class of solar system wanderers named after German astronomer Heinrich Kreutz who, in 1891, published a study of half a dozen of these objects. They are almost impossible to see from Earth because of sunlight and their size. Their orbits cause them to approach Earth between May and October from far behind the Sun and retreat in the same direction. Their small sizes make most of them invisible except during a total eclipse — the very means by which one of the brightest of the sungrazers, the comet of 1882, was located.

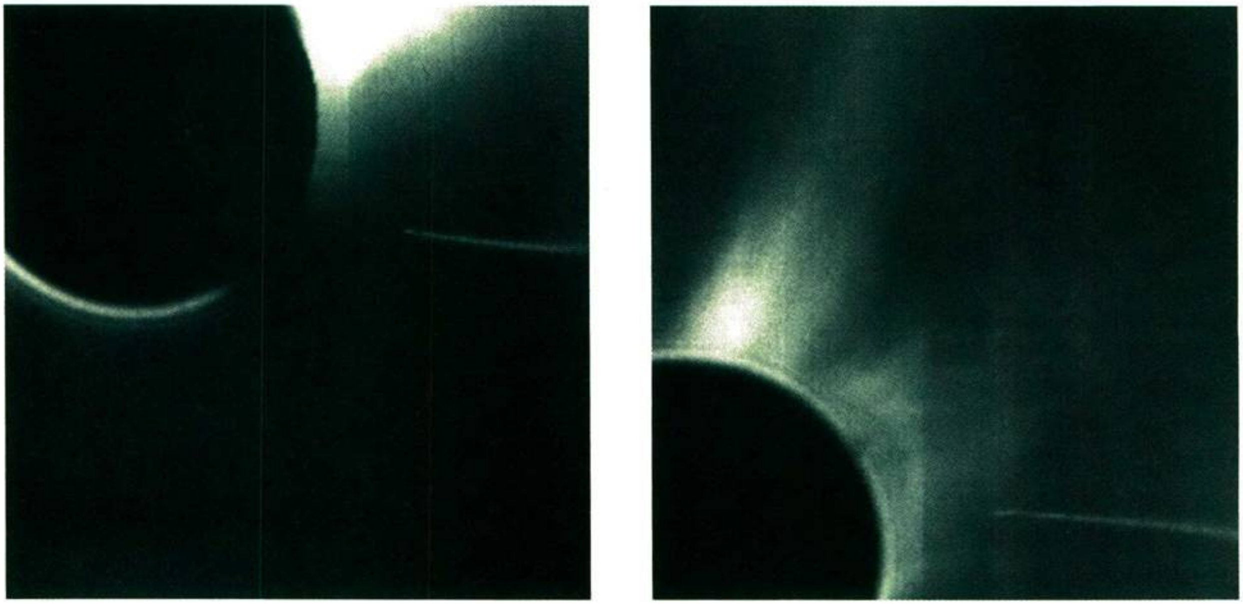
The so-called Kreutz sungrazers approach the Sun from the south and travel in a retrograde orbit, clockwise around the Sun as viewed from above the Sun's north pole. They are examples of long-period comets that wander into space from virtually any direction beyond the outskirts of the solar system, falling into a retrograde orbit. This contrasts markedly with the so-called short-period comets which are well-behaved members of the solar system, reflecting the orderly motion

DESTINATION — SUN! Sungrazing Comet SMM-2 heads for a violent death in this image made on October 17, 1987, with the SMM Coronagraph. All photos courtesy Gerrit L. Verschuur.

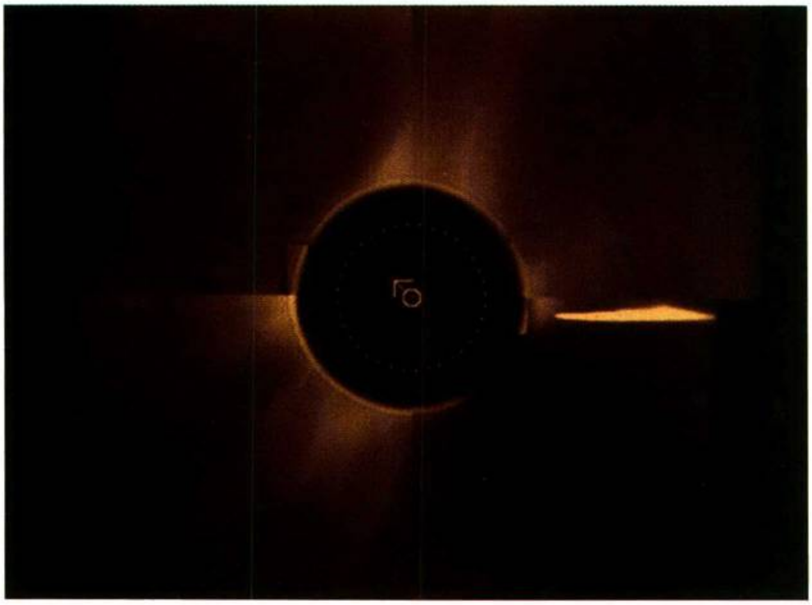
Fragments of once-great comets that are no more, the Kreutz sungrazers brave periodic close encounters with our home star.

by Gerrit L. Verschuur





A ROGUES' GALLERY of Kreutz sungrazers can be found in SMM-2 (above left), SMM-4 (above), SMM-5 (opposite page, left), and SMM-7 (opposite page, right).



BIG, BRIGHT, AND SOON TO PERISH, sungrazer SMM-5 plunges toward the Sun in this image made on October 11, 1988.

expected of matter associated with the formation of the planets. Their orbits lie roughly in the plane of the ecliptic and they travel in the same direction as the planets themselves. In sharp contrast with most comets, the sungrazers can fall in toward the Sun in wild orbits that slam them into the Sun, and they can remain unseen by astronomers — even during and after their demise.

Marsden's family tree for the Kreutz sungrazers allows our imagination to wander. About 15,000 years ago, give or take 5,000, a great comet was visible. Back then New England was under 5,000 feet of ice and you could have skied at an elevation thousands of feet above the Great Lakes. More than a quarter of the world was covered in glaciers, and in Europe Neanderthal hominids had ceased to exist, overwhelmed by the newly dominant species, *Homo sapiens.*

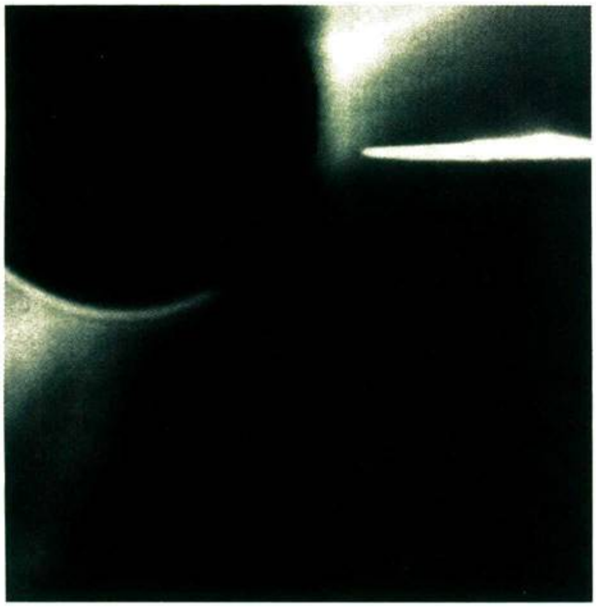
Echoes of an Ancient Past

The Magdelanian people lived in the final stages of the last Ice Age. They were skillful in making things of bone, ivory, and flint, and their art was probably intended as "hunting magic," a ritual incantation to fill the belly. Those people probably saw a great comet that filled their hearts with fear and awe. Here was a natural wonder they could not comprehend, one for which a cave painting provided no succor. They could not have realized that they were seeing great comets that would erode through the ages to produce fragments visible in the night skies of their descendants.

And so it went until one of the fragments filled the skies with a glorious spectacle in 371 BC, the year Aristotle and Ephorus gazed at this cosmic visitor, a mere shadow of its long-forgotten ancestor. This comet had its own close encounter with the Sun, which it survived as two or three fragments that were seen again around 1100. One likely candidate was the comet of 1106.

Fitting Together the Pieces

The offspring of these comets are still in perilous orbits that bring them within a solar radius of the surface of the Sun. They brush within 700,000 kilometers of disaster, and few now manage to escape.



All the fragments observed by the spacecraft in the last decade have disappeared into the cauldron. And this, after traveling from the depths of interstellar space, from about 30 billion kilometers away, seven times as far as Neptune, on journeys around the Sun that last hundreds if not a thousand years.

The comets discovered by SOLWIND and SMM are all distant offspring of the ice age comets. Every one of these fragments disappeared at perihelion. No one is sure whether they crashed, evaporated, or were simply reduced of their volatile substances to the point that they no longer glowed.

The Kreutz sungrazer family consists of several sub-groups. Marsden classified the comets of 1843, 1880, 1887, and 1963 as subgroup I (see box). The SOLWIND and SMM comets also belong to this group.

The second subgroup includes the sungrazers of 1882 and 1965, the latter better known as Comet Ikeya-Seki. These two objects separated at the previous perihelion passage, which occurred around 1100, and one of them may have been the bright comet of 1106. Other members of subgroup II are 1945 II and perhaps bright comets seen in 1689 and 1702. The single member of the third subgroup is Comet 1970 VI.

Few of the current visitors survive their encounter with the Sun. Marsden suggests that the only reason the sungrazer 1963 V survived its perihelion passage was that the gravitational tug of Jupiter managed to sway its path enough to avoid disaster.

The break up of the most spectacular sungrazer in recent times occurred with 1882 II. That event led Heinrich Kreutz to examine the data, and he predicted its four fragments would return in 670, 770, 880, and 960 years. Since the perihelion distances of the fragments evolve with time, bringing them ever closer to the Sun, these four are also likely to be annihilated when they return. Not all of the sungrazers have fallen to their doom. In 1965, Comet Ikeya-Seki lit up the heavens and was seen by millions of people in a rare, brilliant display from a member of a class that typically is notoriously hard to view.

It is very likely that many more small fragments lie in associated orbits. Few (if any) will be seen in the next several years because no coronagraphs are currently in orbit. Until another coronagraph is launched, the best opportunity to look for a Kreutz sungrazer will come during future solar eclipses, when with luck, we might catch one of these elusive comets in the act of being swallowed up by the Sun. ☐

Gerrit L. Verschuur is an astronomer and freelance writer living in Bowie, Maryland. His last article was "Star Dust" in the March 1992 issue.

Subgroup I

1668?
1963 V SOLWIND 1-6 (1979-84) SMM 1-10 (1987-1989)

~1487 (not seen)
1843 I 1880 I 1887 I

Subgroup II

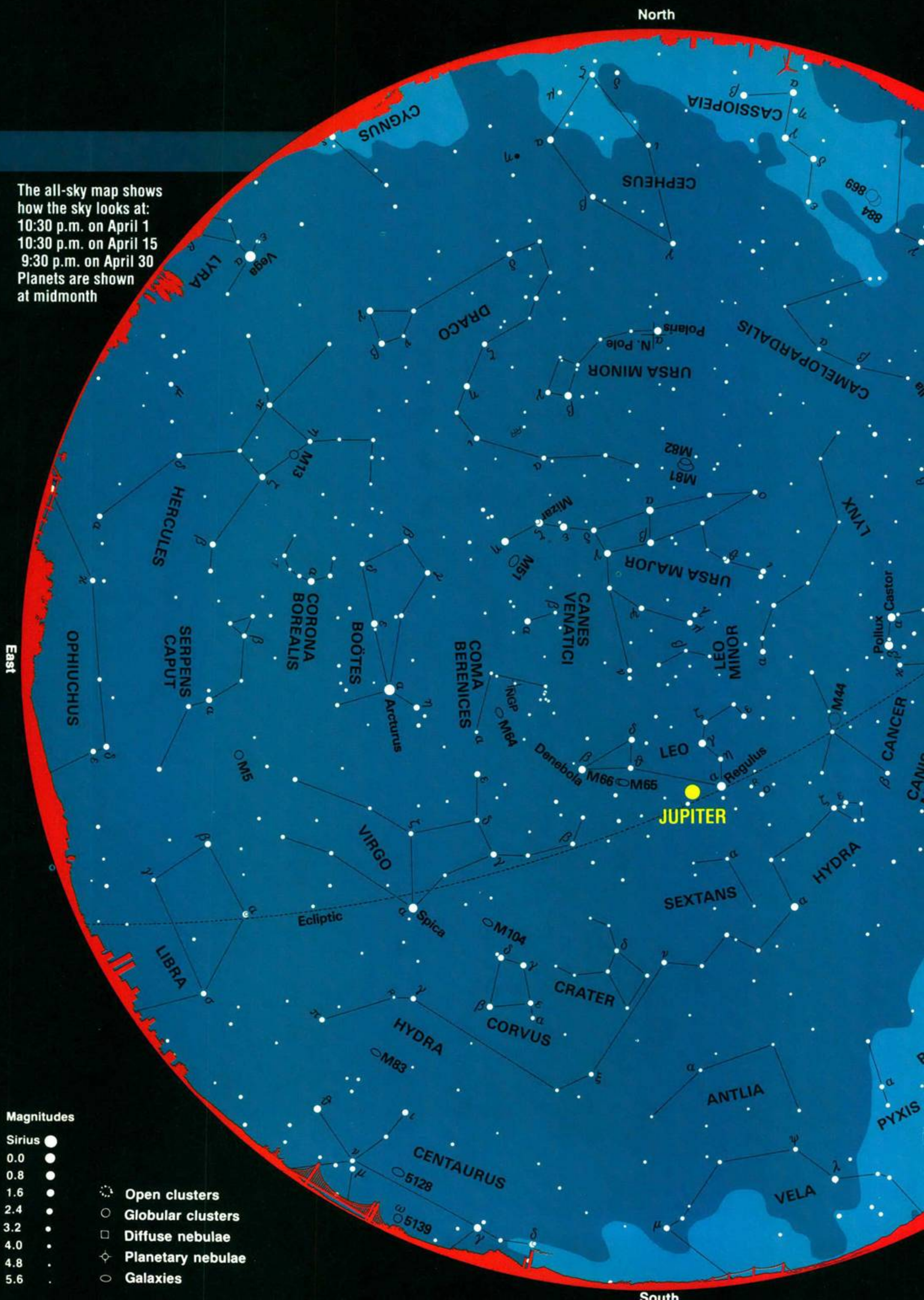
Unknown ancestor
1882 II 1945 VII 1965 VIII (Ikeya-Seki)

Subgroup IIa

Unknown ancestor
1970 VI

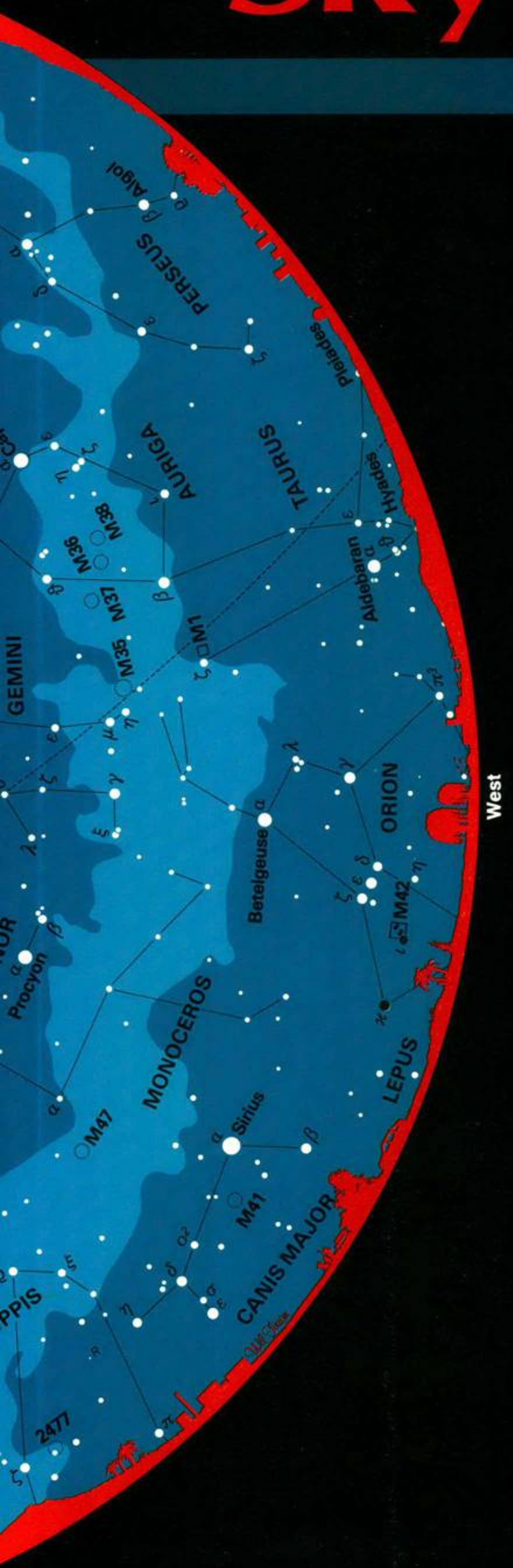
Of the sungrazers above, SOLWIND 1-6 and SMM 1-10 have all disappeared. 1963 V may survive if Jupiter obliges. 1887 I is gone. 1843 I may survive; so might 1880 I. Data based on research by Brian Marsden.

The all-sky map shows
how the sky looks at:
10:30 p.m. on April 1
10:30 p.m. on April 15
9:30 p.m. on April 30
Planets are shown
at midmonth


North
East
South
CYGNUS
CASSIOPEIA
CEPHEUS
869
884
LYRA
Vega
DRACO
Polaris
N. Pole
URSA MINOR
CAMELOPARDALIS
M13
HERCULES
M82
M81
Mizar
M51
URSA MAJOR
LYNX
CORONA BOREALIS
BOÖTES
CANES VENATICI
LEO MINOR
Castor
Pollux
OPHIUCHUS
SERPENS CAPUT
COMA BERENICES
NGP
M64
Arcturus
M44
CANCER
M5
Denebola
M66
M65
LEO
Regulus
JUPITER
VIRGO
HYDRA
SEXTANS
Ecliptic
Spica
M104
LIBRA
CRATER
CORVUS
HYDRA
M83
ANTLIA
PYXIS
CENTAURUS
5128
5139
VELA
Magnitudes
Sirius
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
Open clusters
Globular clusters
Diffuse nebulae
Planetary nebulae
Galaxies

Sky Almanac

April 1992


Algol
PERSEUS
Pleiades
AURIGA
TAURUS
Hyades
Aldebaran
M36
M38
M37
M35
M1
GEMINI
ORION
West
Betelgeuse
M42
Procyon
MONOCEROS
LEPUS
Sirius
M47
M41
CANIS MAJOR
PPIS
2477

SEEKING A YOUNG MOON

Observers across North America have a rare opportunity this month — to see a Moon less than 24 hours old. Look on the evening of April 3 about half an hour after sunset, when the slender crescent Moon lies low in the western twilight. People on the East Coast can see the Moon just 19 hours after it is new, while people on the West Coast can see a 22-hour-old Moon.

NEPTUNE OCCULTED ON APRIL 23

On the morning of April 23, the solar system's most distant planet gets blocked from view by Earth's nearest neighbor. Telescopic observers throughout most of North America can watch the Moon pass in front of Neptune, but only those in Hawaii will see the event in a dark sky.

NINE PLANETS IN A NIGHT

During the first week of April, you have the chance to view all the planets in the solar system in one night. You should have little problem finding Mars, Jupiter, and Saturn, but you'll need a sharp eye to catch Mercury, Venus, and Uranus and a telescope to spot Neptune and Pluto.

Calendar of Events

2 The Moon passes 4° north of Mercury, 3 a.m. EST
3 New Moon is at 12:01 a.m. EST
5 Mercury passes 2° north of Venus, 7 p.m. EDT
10 First Quarter Moon is at 6:06 a.m. EDT
13 The Moon is at perigee (228,498 miles from Earth), 2:54 a.m. EDT
17 Full Moon is at 12:42 a.m. EDT
21 Lyrid meteor shower peaks
22 Neptune is occulted by the Moon, 10 a.m. EDT
Mercury is at greatest western elongation (27°)
24 Last Quarter Moon is at 5:40 p.m. EDT
25 The Moon is at apogee (251,160 miles from Earth), 5:49 a.m. EDT
The Moon passes 5° north of Saturn, 10 p.m. EDT
29 Asteroid Parthenope is at opposition

Eye on the Sky

by Deborah Byrd

TRY TO CATCH A YOUNG MOON

No sight in the heavens is more suggestive of renewal than that of a young Moon. This is the slender crescent that appears in the western evening twilight a day or two after New Moon, when our companion world goes between us and the Sun. You can't see a New Moon because of the Sun's glare. Instead, in the days before the New phase, the old Moon wanes to a slim crescent in the east before dawn. The Moon then disappears for a few days, only to return as a young Moon in the west at dusk.

It's appropriate that springtime — when the Northern Hemisphere is undergoing its own renewal — brings the year's best opportunities to see the young Moon. The ecliptic — the apparent path of the Sun, Moon, and planets across the sky — is nearly perpendicular to the horizon on spring evenings. Thus at this time of year, the young Moon's angular distance from the Sun translates to a distance nearly straight up from the western horizon after sunset. That makes the Moon easiest to see.

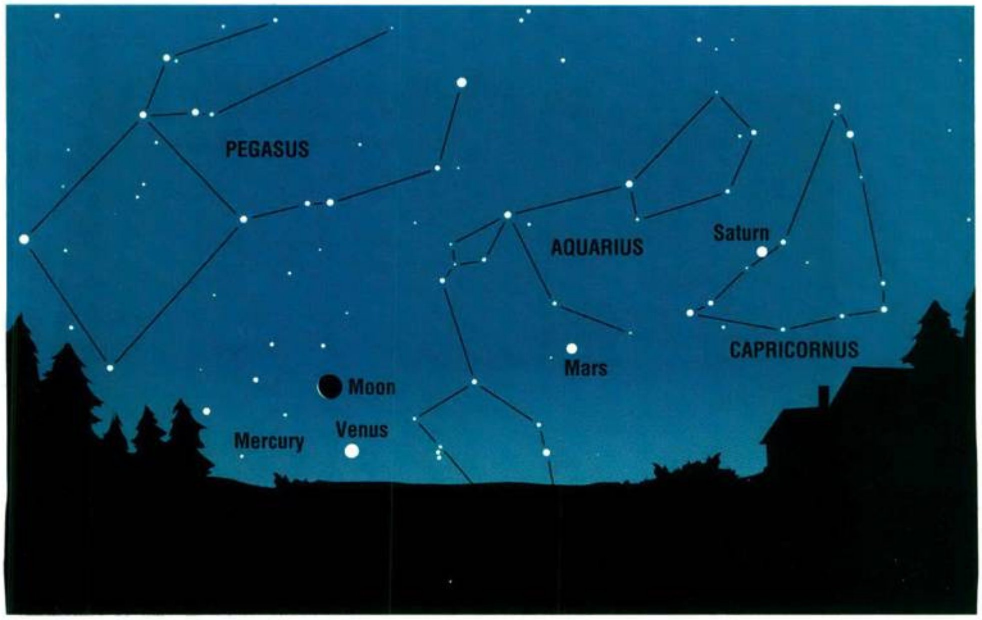
Unless you make a concerted effort, it's hard to see a Moon less than 24 hours old. On the evening of April 3, however, you may glimpse a Moon younger than that. That evening, the Moon is only 19 hours old as seen from the East Coast. For each time zone farther west, the Moon is an hour older.

Start looking for the young Moon no later than half an hour after sunset. It is essential that you have good sky conditions — with no haze, smog, or clouds near the horizon. If you have binoculars, use them to scan along the western horizon. Because the Moon is fresh from having passed between us and the Sun, it appears as the most fragile of crescents. People of all ages — from young children to grandparents — delight in the sight of a young Moon. Good luck!

MERCURY AND VENUS COME TOGETHER

The two inner planets offer a second observing challenge for you to try this month. Neither Mercury nor Venus ever strays far from the Sun in our sky, and this month both are extremely low in the east before dawn. Still, if you have a stretch of clear weather, a good pair of binoculars, and a steady hand for scanning near the horizon, you might glimpse the dance of these planets in the predawn twilight.

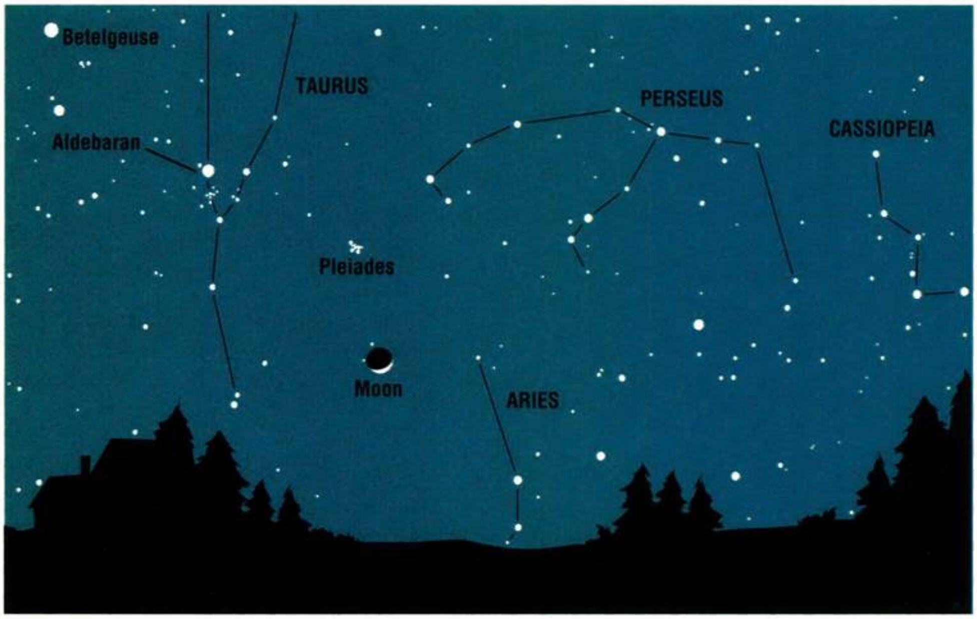
FOUR PLANETS GATHER in the morning sky in early April, creating a striking sight in the east 20 minutes before the Sun rises. On the morning of April 1, a slim crescent Moon joins the planetary quartet.



Venus, the brightest of all the planets, is already immersed in very bright twilight when the month begins. As seen from 40° north latitude on April 1, the planet comes up a little more than half an hour before the Sun. From the southern United States, you can see the planet slightly more easily. On April 1, Mercury is 9° to the left of Venus. The Moon happens to be in the same vicinity as well. It lies above the two planets in the eastern predawn sky. You'll certainly need binoculars to have any hope of seeing Mercury, and you might need them for Venus and the Moon too!

After the 1st, the Moon disappears into the dawn. Mercury, on the other hand, moves higher in the predawn sky. It passes 2° north of Venus on April 5. After that, you can pretty much forget about Venus. It slips quietly into the dawn later this month. It will pass behind the Sun in mid-June.

Mercury's greatest elongation — when it is farthest from the Sun for this morning apparition — comes on April 23. The planet lies 27° west of the Sun that day, but because the ecliptic makes a shallow angle relative to the horizon in the morning at this time of year, it is still quite low in the east. The best time to search for Mercury is during the week of its greatest elongation. Try looking first for the two other predawn planets, Saturn and Mars, which lie in the southeast before dawn. A line between them points to the innermost planet.



THE MOON AND PLEIADES lie just 8° apart on the evening of April 5, when they appear low in the west at the end of twilight.

A PAIR OF METEOR SHOWERS

Two meteor showers reach their peak this month. The Lyrid shower, normally the better of the two, peaks on April 21. Unfortunately, the Moon is in a waning gibbous phase and its light drowns all but the brightest meteors from view. The Virginid meteor shower peaks on the morning of April 12, but produces only about 5 to 10 meteors per hour. Still, the Moon is out of the way that morning, so you should see some meteors from a dark country location.

APRIL'S PLANETS

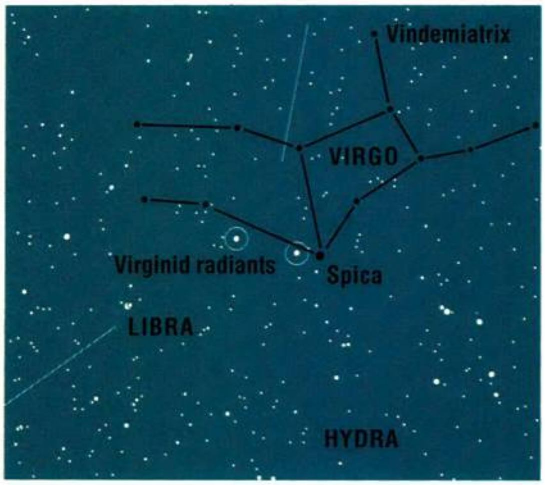
Jupiter shines brightly in the south during the early evening hours. At magnitude –2.3, it easily outshines the background stars of Leo the Lion. The giant planet begins the month only about 6° from Regulus, Leo's brightest star. Every night, Jupiter trails close behind Regulus as the sky turns overhead and the stars shift toward the west. Because it is now moving westward, or retrograde, with respect to the stars, Jupiter creeps about a degree closer to Regulus during the course of April. The planet becomes stationary on May 1, so next month it will begin moving slowly eastward, away from Regulus again. Look for Jupiter and Regulus near the Moon on the night of April 12.

Jupiter remains the lone naked-eye planet until **Saturn** rises nearly three hours before the Sun. The ringed planet lies in the southeast at dawn, among the stars of Capricornus, and shines at magnitude 0.8. The planet rises earlier each morning throughout the month, so it gradually climbs higher in the southeast. Look for it near the Moon on the mornings of April 25 and 26.

Mars is the faint ruddy light in the east-southeast before dawn. At magnitude 1.1, it appears a little brighter this month than last. As Saturn ascends in the predawn sky during the course of April, Mars seems to stay put, hovering near the horizon. That's because it is now moving toward the east in front of the stars fast enough that it nearly keeps pace with the Sun's apparent motion. The Red Planet spends most of the month within the boundaries of Aquarius, but it crosses into Pisces before month's end. The waning Moon sweeps near Mars on the mornings of April 28 and 29.

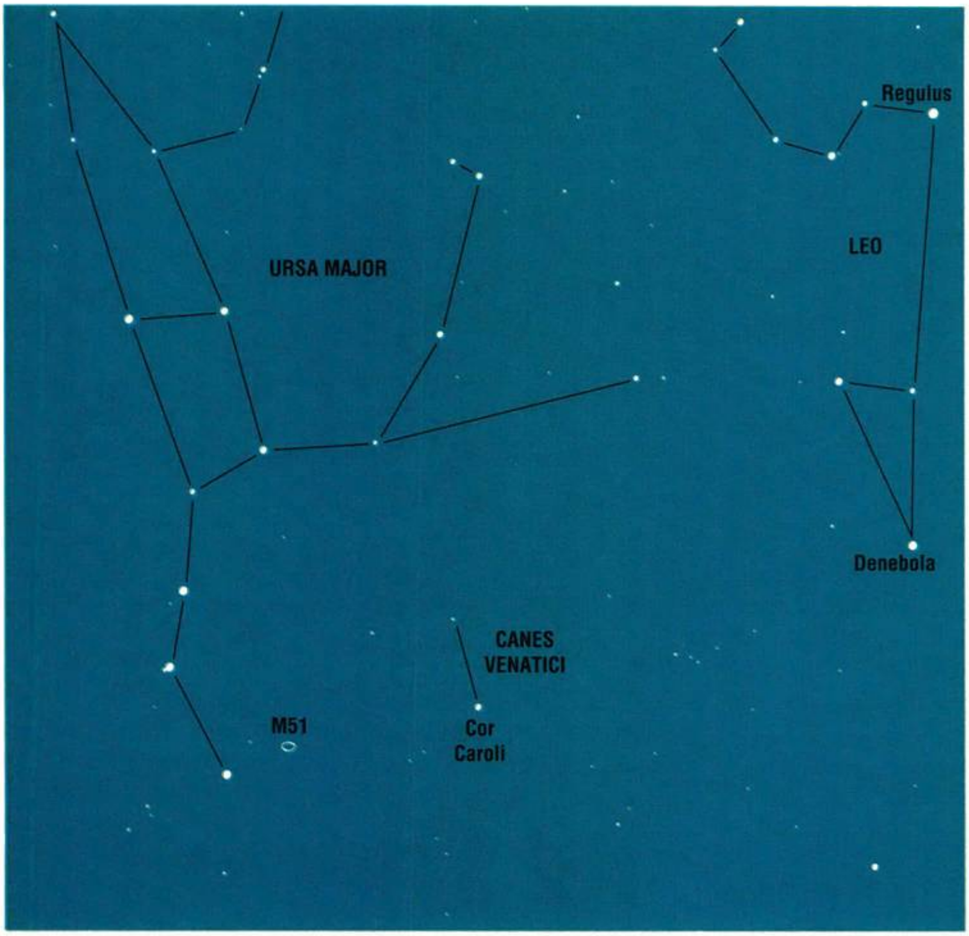
In early April, **Venus** rises in the east just before the Sun does. If this planet weren't so bright (magnitude –3.9), there'd be no hope of your seeing it against the brightening dawn sky. As it is, you can find Venus by drawing a line between Mars and Saturn and extending it

LONG PATHS and slow motions characterize Virginid meteors, which peak in activity on April 12. You can see up to 10 meteors per hour coming from two prominent radiants in Virgo.



toward the horizon. A good time to try to see Venus is April 1, when it rises 6° to the lower right of the old Moon.

Mercury lies 9° to the left of Venus on April 1, but you'll need binoculars to see it then. In fact, the entire month might pass without your ever seeing Mercury with the naked eye. Even though the planet lies 27° from the Sun at its April 23 greatest elongation, it remains difficult to see because of the ecliptic's shallow angle relative to the eastern horizon in the morning sky.



THE HUNTING DOGS of Canes Venatici lie about halfway up in the northeast — between the Big Dipper's handle and the hindquarters of Leo the Lion — early on April evenings.

THE STARRY SKY

As the early spring twilight fades into night, the stars of the Big Dipper ascend in the northeast. This is a good time to look for the tiny constellation Canes Venatici, the Hunting Dogs. The constellation lies just south of the Dipper's handle.

We have Johannes Hevelius, a 17th-century Polish astronomer, to thank for this constellation. For centuries these stars — the brightest of which are 3rd and 4th magnitude — were considered part of Ursa Major, the constellation that contains the Big Dipper asterism. Hevelius was the first to represent Canes Venatici as a separate constellation, in his star atlas published posthumously in 1690.

As you look at Canes Venatici, only two stars stand out. The brighter star shines at 3rd magnitude. It represents Chara, one of the Hunting Dogs. The other star shines at 4th magnitude and represents the second dog, which is named Asterion. Even in a sky packed to overflowing with layer upon layer of mythological beings and animals, this constellation is amazing for providing so much story for so few stars.

The brighter star has a proper name. It is Cor Caroli, or "heart of Charles." One story goes that the star was named by Edmond Halley for Charles II of England. In this version of the name's history, a court physician claimed that the star "shone with special brilliance" on the night of the king's return to London in 1660. More recently Deborah J. Warner, a noted sky historian, has said that the original star name was "Cor Caroli Regis Martyris" in honor of Charles I, who was executed.

Cor Caroli is a beautiful double star when seen through a small telescope. However, the best-known telescopic sight in this constellation is M51, the famous Whirlpool Galaxy. From a dark location on a moonless night, you can locate this galaxy with good binoculars. In a small telescope, this object appears as a fuzzy patch of light having a slightly brighter center. This dim patch of light is actually a spiral galaxy oriented nearly face-on to Earth and located about 35 million light-years away, a mirror of sorts to our own Milky Way. □

Deborah Byrd's new radio series, "Earth and Sky," can be heard on stations in the United States, Canada, and Guam.

Through the Eyepiece

by Rick Shaffer

THE MOON OCCULTS NEPTUNE

On the morning of April 23, observers in most of North America and in Hawaii can see the Moon occult the most distant planet, Neptune. Unfortunately, only people in Hawaii will see the event in a dark sky. And because it is a morning event, Neptune disappears behind the sunlit limb of the 20.3-day old Moon and reappears from behind the unlit limb.

If you've only recently discovered the joys of backyard observing, this occultation of Neptune may offer you your first chance to view what is currently the most distant planet from the Sun. If you're an experienced observer, this event is impressive because viewing it with your telescope is a great challenge.

Observing Neptune pass behind the Moon is challenging because the two differ so much in brightness. The Moon's average surface brightness is approximately 270 times greater than that of Neptune, so any source of stray light from the Moon will keep you from seeing Neptune at all. The solution? Maximize the performance of your optical system before the big event.

First, consider which instrument to use. Your best bet is the largest telescope available that provides a reasonably bright view of Neptune and is unobstructed by a diagonal and its supports. Given the choice between a good 6-inch refractor and an 8-inch reflector, choose the unobstructed refractor. Before you make a final choice, however, it pays to observe Neptune several times with all the instruments at your disposal to see which gives the best view.

Another good option is to use a very large Newtonian that you've stopped-down with an off-axis circular mask so the diagonal and its supports don't intercept the light from the sky. If I lived in Hawaii, I'd probably view the occultation through my 20-inch Newtonian stopped-down to 7.5 inches of unobstructed aperture.

Another alternative is to observe the occultation from an amateur or school observatory in your area. If you present a reasonable plan for observing the occultation, you might be allowed to use one of those facilities.

Next, make sure every element of your optical system is scrupulously clean. This event is the perfect excuse to clean your optics, particularly if you haven't done it in some time. And for those of you who wear glasses, don't forget to give them a good cleaning, too. (For details on cleaning your scope, see "How to Clean Your Mirror" by Michael Porcellino in the March issue.)

This is also a good time to reduce the glare coming from the inside of your telescope's tube and dew-cap. Either black felt or flocked paper works well as a lining for the inside of your tube.

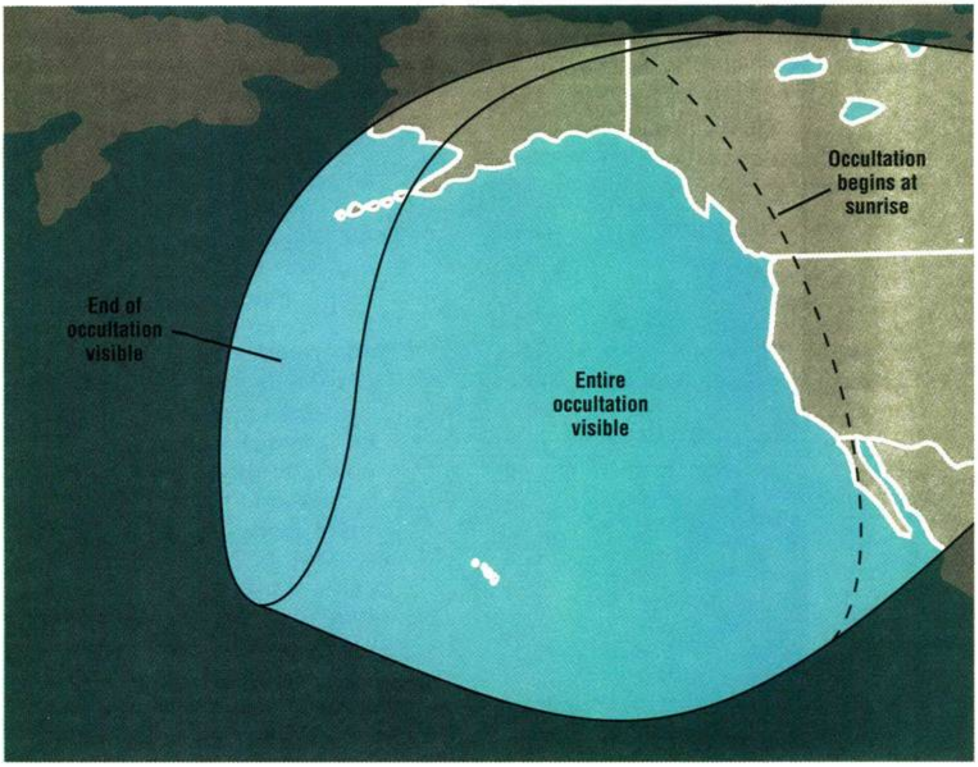
A final trick you can try is to take a small piece of neutral-density filter and place it in the focal plane of your eyepiece. When observing the occultation, keep the Moon behind the filter, except for a tiny sliver where Neptune will disappear. However, you'll probably need good

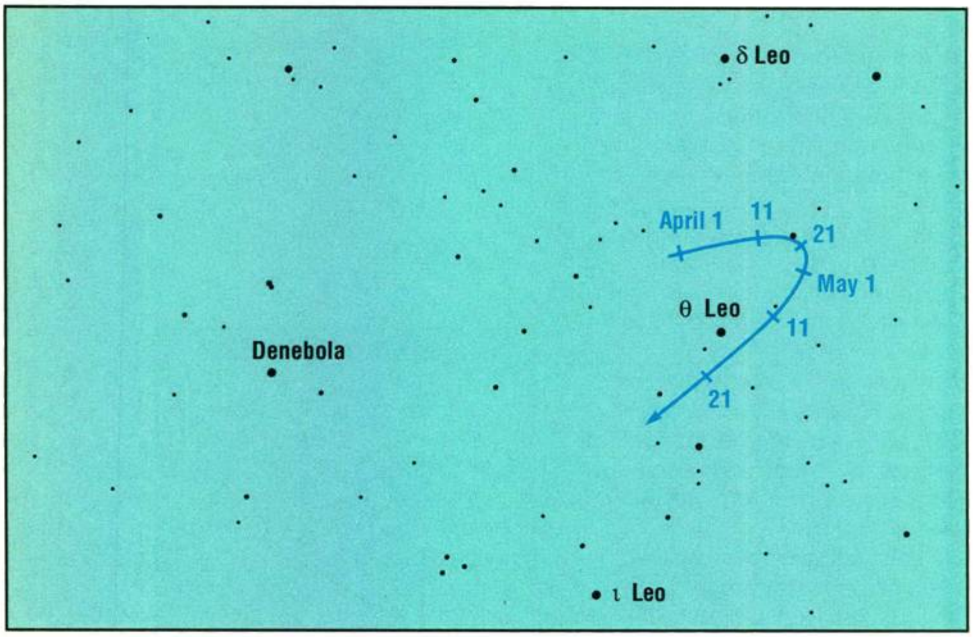
OCCULTATION OF NEPTUNE

City	Time	Position Angle
Anchorage	13h34m	308°
Honolulu	12h45m	241°
Mauna Kea	12h48m	238°

Neptune reappears from behind the dark limb of the Moon at the universal times and position angles shown.

NEPTUNE DISAPPEARS behind the Moon for observers in most of North America on the morning of April 23. The entire occultation is visible east of the oval area, but it begins after sunrise to the east of the dashed line.


Occultation begins at sunrise
End of occultation visible
Entire occultation visible



VESTA REMAINS a reasonably bright object in eastern Leo throughout April and early May, fading slightly during that period from 6th to 7th magnitude. Positions are shown for 0h UT.

slow-motion controls on your telescope to maneuver the image into just the right orientation with respect to the "filter bar."

Now for a bit of observing strategy: First, locate Neptune at least an hour before the event so you can experiment with the best power to use as the Moon passes in front of the distant gas giant. Neptune disappears at 11h32m UT (1:32 a.m. local time) as seen from Honolulu, Hawaii, and an hour before then Neptune lies 0.5° east of the Moon's limb. It's even more important to find Neptune early if you live in the continental United States or in Canada. Your chances of finding the planet are pretty slim if you wait until after daybreak.

A final warning: I've never seen the Moon occult Neptune before, so this will be as new an experience for me as it is for most of you. But even if we don't see the occultation, the worst that will happen is that we'll have cleaned our telescopes and had good views of Neptune and the Moon.

COORDINATES FOR VESTA

Date	R.A. (2000)	Dec.
April 1	11h17.5m	16°53'
April 6	11h14.1m	17°05'
April 11	11h11.4m	17°11'
April 16	11h09.4m	17°10'
April 21	11h08.1m	17°02'
April 26	11h07.5m	16°49'
May 1	11h07.7m	16°31'
May 6	11h08.6m	16°08'
May 11	11h10.2m	15°40'
May 16	11h12.4m	15°09'
May 21	11h15.3m	14°34'

A SOLAR SYSTEM'S WORTH OF PLANETS

During the first week of April, you can, in just a few hours' observing time in the morning, see all nine planets in our solar system. Begin your tour with the easiest planet of all — the one that lies at your feet. Then shift your gaze upward to Jupiter, which lies low in the western sky around 2 a.m. local time.

Your next (and by far most difficult) target is distant Pluto. You'll need at least a 6-inch telescope to spot Pluto, which on the 1st resides in Serpens Caput at a right ascension of 15h36.4m and declination of –3°44'. However, to verify that you're really seeing Pluto, you need to observe its field the night before to distinguish which 14th-magnitude "star" in the field has moved. The best way to do this is to make a detailed sketch showing every star in the field on both nights.

After Pluto come Uranus and Neptune, whose blue-green disks you'll find just north of the handle of the Teapot asterism in Sagittarius. Next comes Saturn, which is both easy to find among the stars of Capricornus and, as always, a pleasure to observe.

As you proceed toward the eastern horizon, your next stop is Mars. The Red Planet's 1.2-magnitude disk is only 4.6" in diameter and it lies close to the horizon, so you likely won't see much detail on the surface.

The remaining two planets will test your observing skill, even though they are quite bright. Both Mercury and Venus are near the Sun in the sky and rise less than an hour before it. Even though it's a bit closer to the Sun than Mercury, Venus is easier to see because it is several magnitudes brighter. If you look a bit south of due east 30 minutes before sunrise, you'll see the brilliant –3.9-magnitude Venus rising out of the dusky sky. As soon as you spot Venus, you should look for the much dimmer Mercury just a few degrees to its left. Because both planets lie so close to the horizon, don't expect to do much more than identify them.

TELESCOPIC PLANETS

Because we've just taken a tour of all the planets, I won't dwell on each one here. You should realize that **Venus** is essentially unobservable after the beginning of the month. And even then, "detectable" is probably a more appropriate description for the 10.5"-diameter, 95-percent-lit disk of the bright planet.

Unlike Venus, **Mercury** rises out of the horizon murk as the month progresses. Mercury reaches greatest elongation on April 23, but this is a rather poor apparition for the innermost planet. Consider yourself lucky if the seeing allows you to observe Mercury's 7.9"-diameter, 45-percent-lit disk that morning.

Although **Mars** is observable, its small apparent size means that you'll need exquisite seeing to discern much on its disk. Your best bet is to look for the planet's south polar cap. It is late fall in Mars' southern hemisphere and that region is now tilted at its maximum angle to Earth.

The outer gas giants, **Uranus** and **Neptune**, offer even less than Mars. All you can see on these planets is their blue-green disks. For Uranus, its disk glows at 6th magnitude and measures 3.6" across, while Neptune glows at 8th magnitude and features a 2.2"-diameter disk.

The great gas giants, **Jupiter** and **Saturn**, are both reasonably well-placed for observation this month. Jupiter is an easy evening object during April. In fact, it should be your main focus at any spring star parties you might host.

As you observe Jupiter's 42"-diameter disk, remember that you'll see the most detail when the exit pupil of your telescope is between 0.5 and 1.0 millimeters in diameter. (The exit pupil is simply the aperture divided by the power.) So if you're using a 150mm (6-inch) telescope, try to use a power in the range between 150x and 300x. The seeing likely will force you to observe at the lower end of that range.

If you're showing Jupiter to someone who hasn't seen it in a telescope before, think about using an eyepiece-Barlow lens combination to give you the longest eye-relief possible. Also, try a blue filter to bring up the contrast between the dark belts and light zones.

You may be observing Saturn alone, because few star party attendees will stay around late enough to view Saturn when it's high in the sky. But the planet's 16"-diameter disk and 37"-diameter ring system are worth losing a little sleep over. Remember that you can continue observing Saturn well past sunrise.

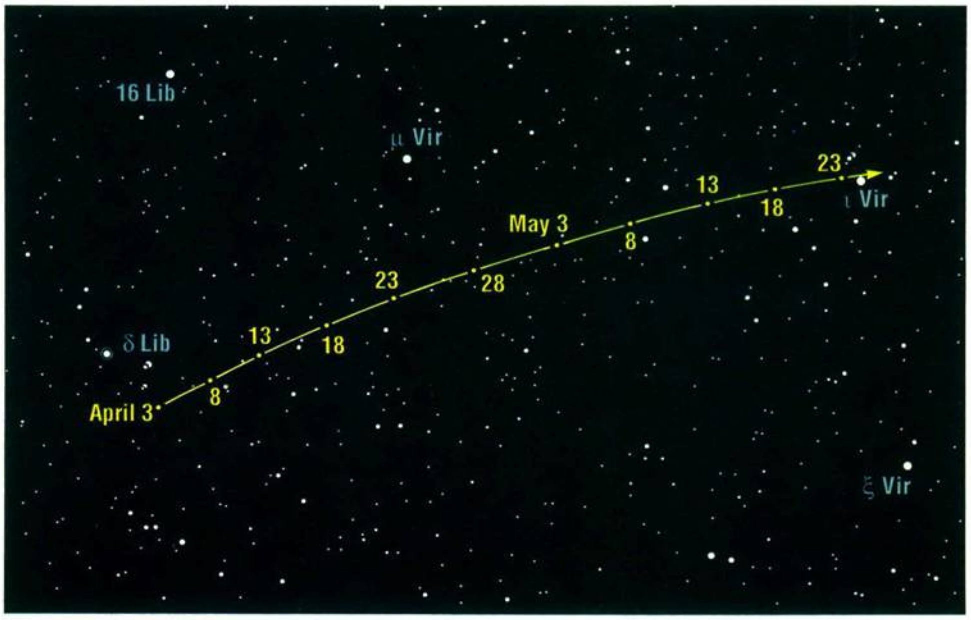
ASTEROIDS IN THE EYEPIECE

The brightest asteroid this month remains **Vesta**, which reached opposition in March. It fades only from magnitude 6.2 to 6.8 during April and is quite easy to find in eastern Leo. The brightest asteroid to reach opposition this month, however, is **11 Parthenope**. This chunk of rock measures about 90 miles in diameter and reflects enough light in our direction to glow faintly at magnitude 9.7. You can find Vesta with the aid of the finder chart or table of coordinates on the opposite page, while Parthenope will come into view with the help of the map and table at right. ☐

Rick Shaffer is an engineer and writer in the aerospace industry in southern California.

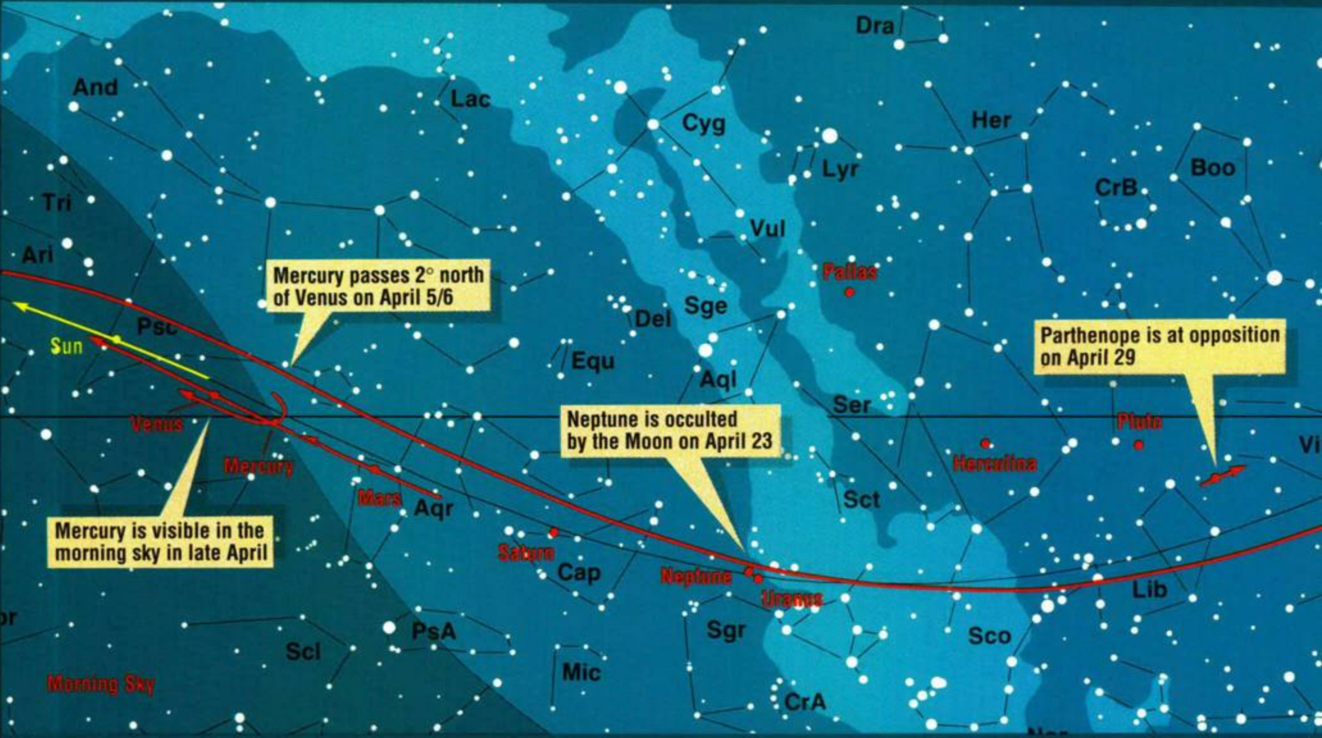
COORDINATES FOR PARTHENOPE

Date	R.A. (2000)	Dec.
April 3	14h57.8m	−9°20'
April 8	14h55.0m	−8°58'
April 13	14h51.6m	−8°34'
April 18	14h47.7m	−8°09'
April 23	14h43.5m	−7°44'
April 28	14h38.9m	−7°20'
May 3	14h34.3m	−6°58'
May 8	14h29.6m	−6°37'
May 13	14h25.2m	−6°20'
May 18	14h21.1m	−6°06'
May 23	14h17.3m	−5°55'



ASTEROID 11 PARTHENOPE moves from Libra into Virgo this month, where it reaches opposition on April 29 and shines at magnitude 9.7. Positions are shown for 0h UT.

The Solar System *April 1992*

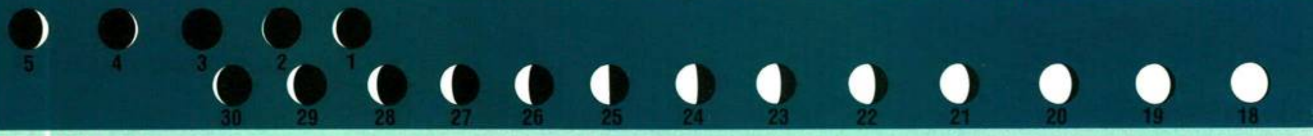

Dra
And
Lac
Cyg
Her
Lyr
Boo
CrB
Tri
Vul
Ari
Pallas
Psc
Sun
Del
Sge
Equ
Aql
Ser
Venus
Mercury
Mars
Aqr
Pluto
Vi
Herculina
Sct
Saturn
Cap
Neptune
Uranus
Lib
or
Sgr
Sco
PsA
Scl
Mic
CrA
Morning Sky

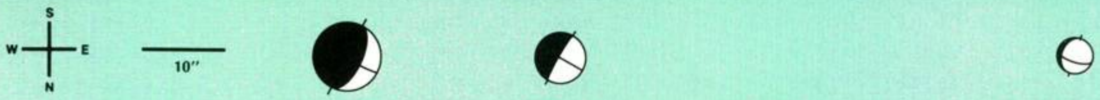
Mercury passes 2° north of Venus on April 5/6

Parthenope is at opposition on April 29

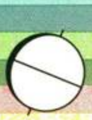
Neptune is occulted by the Moon on April 23

Mercury is visible in the morning sky in late April


5
4
3
2
1
30
29
28
27
26
25
24
23
22
21
20
19
18

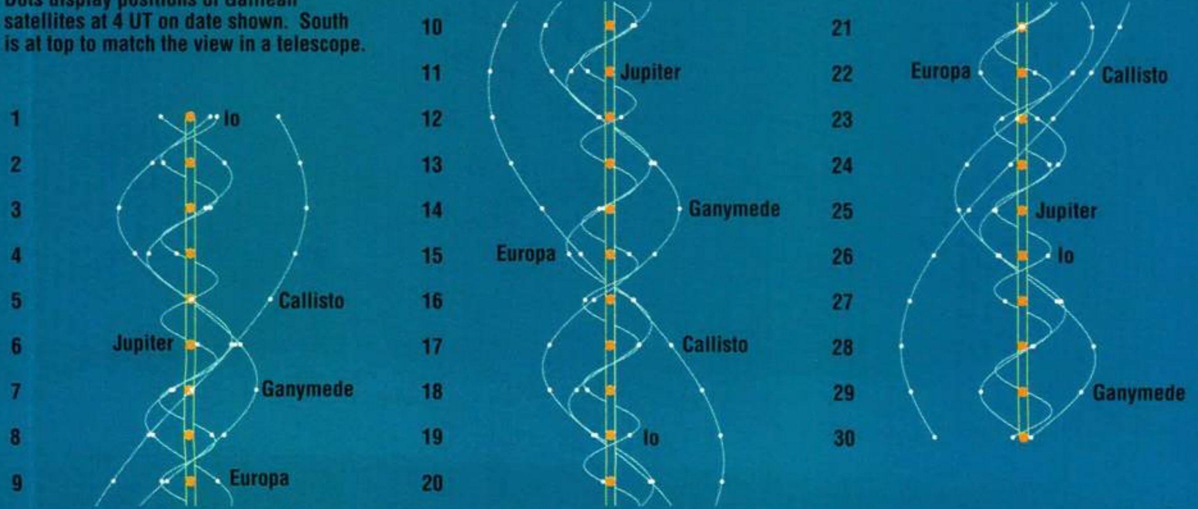


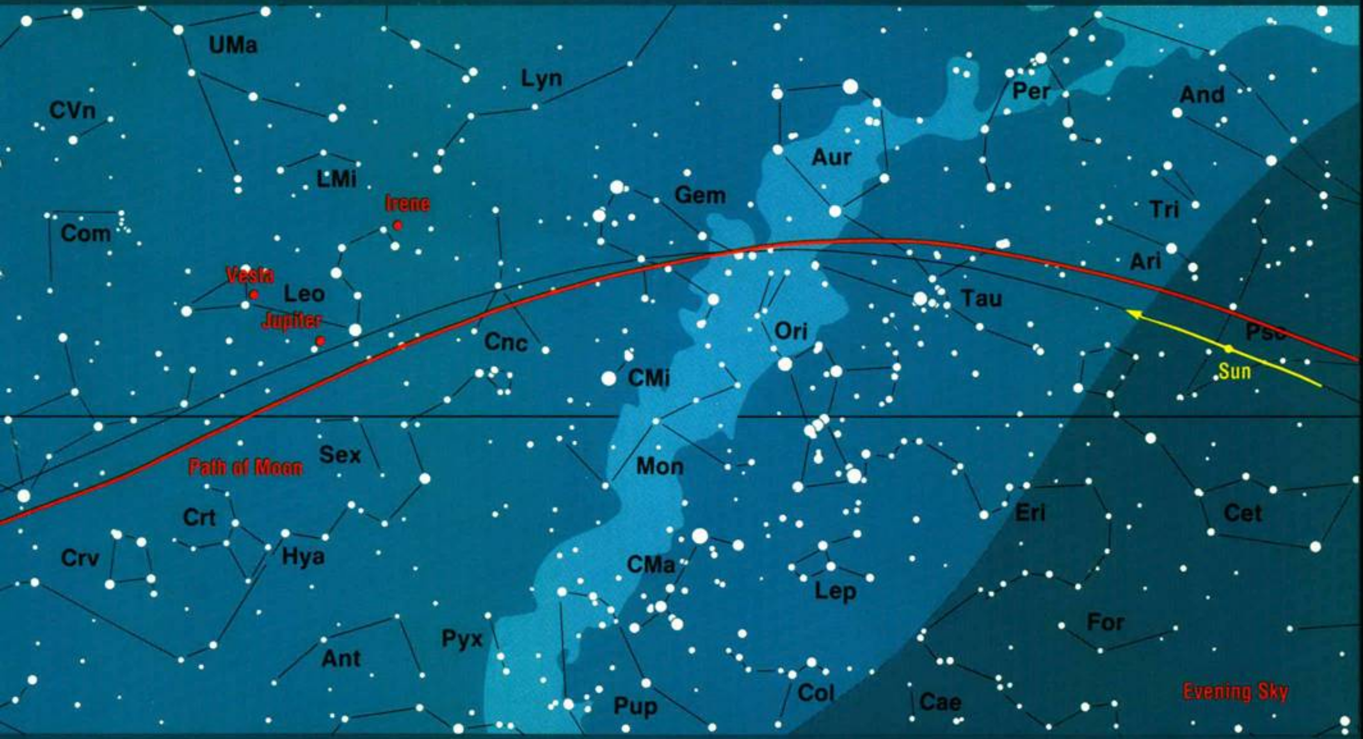
Planet	MERCURY	MERCURY	VENUS	MARS
Date	April 15	April 30	April 15	April 15
Magnitude	+0.9	+0.2	–3.9	+1.1
Angular Size	9.3"	7.1"	10.2"	4.7"
Illumination	30%	55%	96%	94%
Distance (AU) from Earth	0.725	0.946	1.639	1.972
Distance (AU) from Sun	0.465	0.449	0.727	1.389
Right Ascension (2000.0)	0h03.1m	0h55.3m	0h37.6m	23h03.0m
Declination (2000.0)	–1°14'	2°46'	2°25'	–7°30'

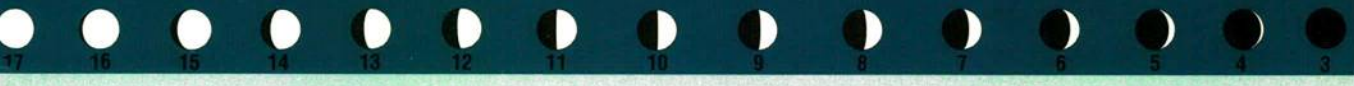


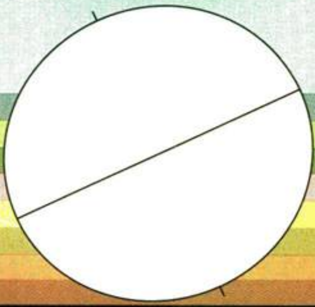
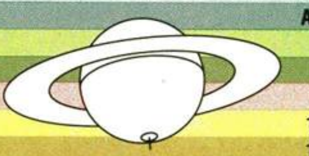
Jupiter's Moons

Dots display positions of Galilean satellites at 4 UT on date shown. South is at top to match the view in a telescope.



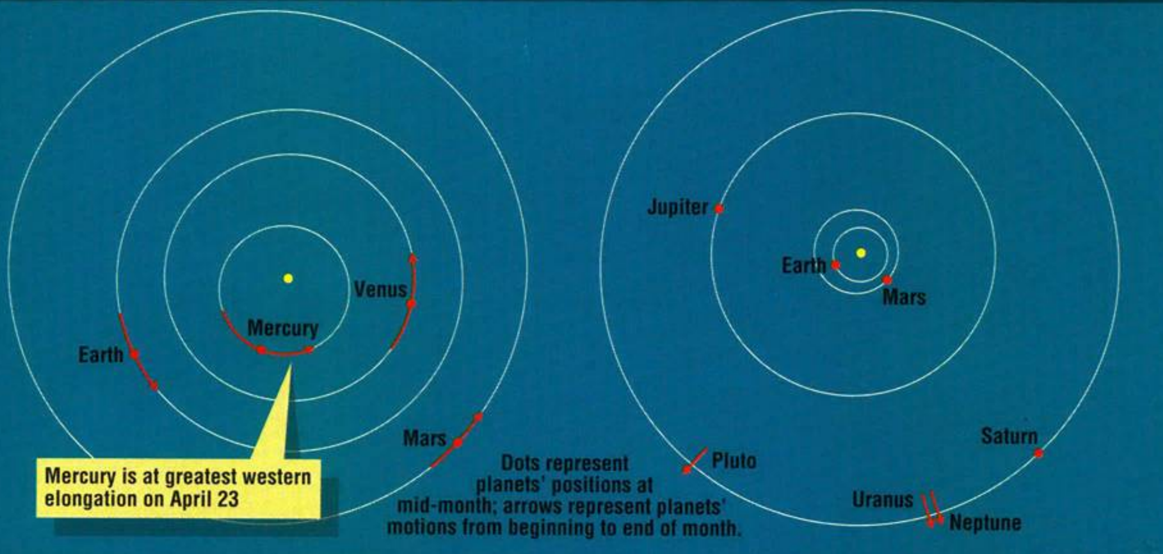

UMa
CVn
Lyn
Per
And
LMi
Aur
Irene
Com
Gem
Tri
Vesta
Ari
Leo
Tau
Jupiter
Cnc
Ori
Psc
Sun
CMi
Path of Moon
Sex
Mon
Eri
Cet
Crt
Crv
Hya
CMa
Lep
For
Ant
Pyx
Col
Cae
Pup
Evening Sky


17
16
15
14
13
12
11
10
9
8
7
6
5
4
3

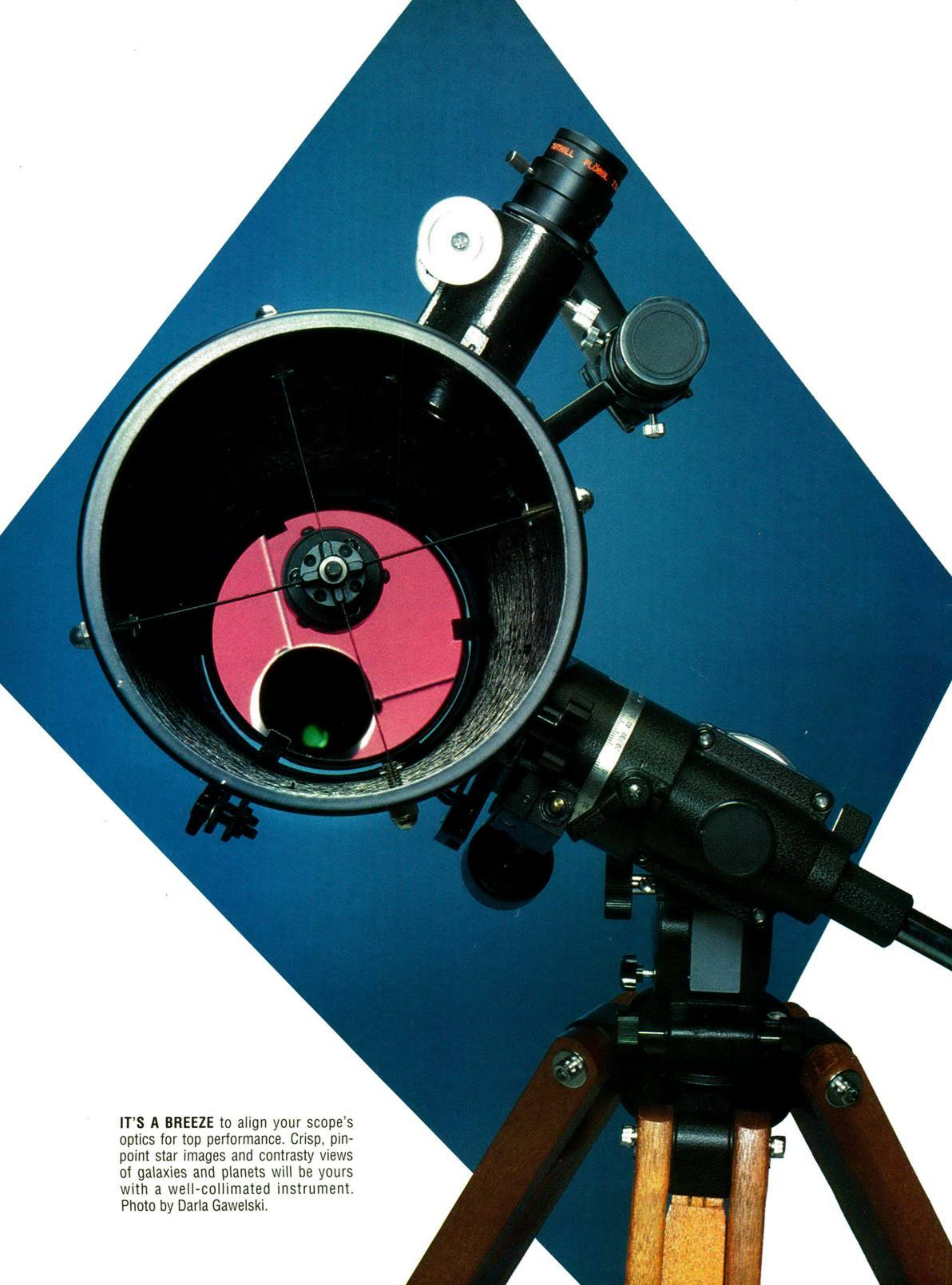
JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
April 15	April 15	April 15	April 15	April 15
−2.3	+0.8	+5.7	+7.9	+13.7
41.8"	16.1"	3.6"	2.2"	0.1"
99%	100%	100%	100%	100%
4.715	10.244	19.375	30.066	28.829
5.412	9.917	19.528	30.193	29.696
10h29.8m	21h19.1m	19h18.7m	19h22.1m	15h35.4m
10°53'	−16°25'	−22°37'	−21°21'	−3°37'

The Planets in Their Orbits


Venus
Mercury
Earth
Mars
Jupiter
Earth
Mars
Pluto
Saturn
Uranus
Neptune

Mercury is at greatest western elongation on April 23

Dots represent planets' positions at mid-month; arrows represent planets' motions from beginning to end of month.



IT'S A BREEZE to align your scope's optics for top performance. Crisp, pinpoint star images and contrasty views of galaxies and planets will be yours with a well-collimated instrument. Photo by Darla Gawelski.

How to Collimate Your Telescope

Is your telescope producing images that resemble bloated butterflies? Solve the problem with this straightforward technique of telescope collimation.

by Michael Porcellino

"This telescope doesn't work — it has never given me good star images." I can't remember how many times I've heard that line at a star party. More often than not, the telescope is fine. The most common problem that produces fuzzy star images in telescopes occurs when the elements of the optical system are not precisely aligned. Rather than deliver a clean, small, image, the telescope scatters light and provides distorted images.

Proper collimation is simple to do and will bring out the best in your telescope's performance. Yet for some reason many amateur astronomers put off collimating their telescopes. Don't become one of these collimation procrastinators. Do yourself a big favor and check periodically to see that the telescope's optics are properly aligned. If they aren't, follow the simple steps below to bring your Newtonian or Schmidt-Cassegrain telescope back into top-notch operating condition.

Collimating Your Newtonian

Before discussing collimation, let's review the components of a simple Newtonian telescope. At the heart of your reflector's optical train is the primary mirror, which sits in a cell at the bottom of the tube. Light striking the primary is reflected back up the tube to a second, smaller mirror called the secondary or diagonal. The secondary rests in a tiny cell held in place by a "spider," two or more thin strips of metal. Light reflected from the primary bounces off the secondary and passes through the tube and into the eyepiece.

When you collimate your telescope's optical train, you will be making sure that the incoming light travels along a straight path from the primary mirror to your eye. Once the optics are collimated, the improvement in image quality will seem almost magical. To work this magic you don't need anything special, only a screwdriver, an Allen wrench, a needle or X-Acto knife, and an old plastic film canister. The actual work should be done in two steps — rough collimation during the daylight and star-testing to precisely align at night.

Before you start, remove the plastic lid from the film canister. In the center of this lid you will see a small dimple. Use a needle to carefully make a small hole in the center of the dimple. Then, using an X-Acto knife or razor blade, cut off the bottom of the can. Replace the lid on the can and you will have a sighting device. This little collimation tool will keep your eye centered in the eyepiece holder as you look into the telescope.

Proper collimation, easy to do, keeps you happy with your scope's performance.

Daylight Rough Collimation

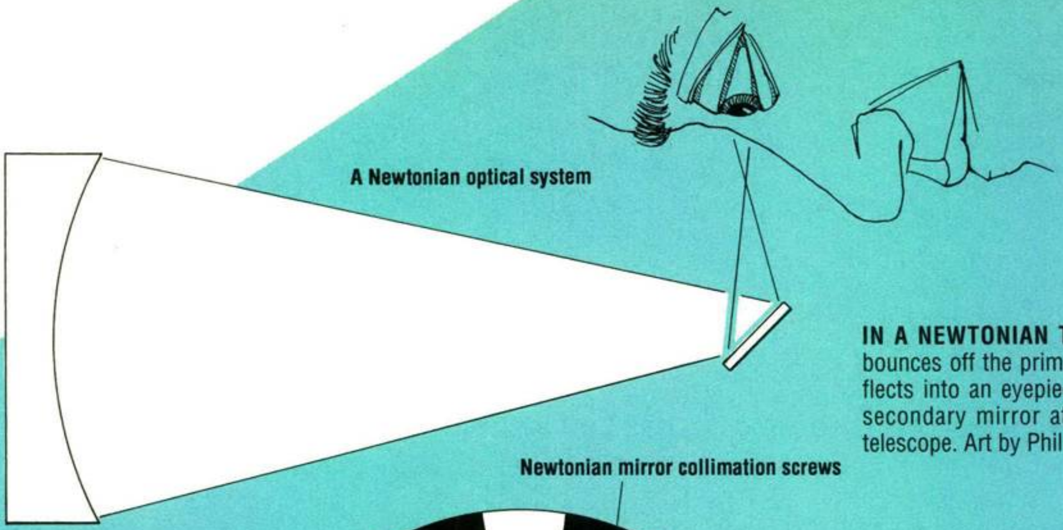
When you're ready to begin, set up your scope during the day and take a few minutes to inspect the mirror cell at the bottom of the tube. At the back of the cell, facing out, is a set of screws. Some cells have three thumbscrews positioned 120° apart. Other scopes have three sets of two screws set at the same angle, called push-pull screws. Whether the scope has three or six screws, their function is the same: to move the mirror in the cell and direct the light reflected by the mirror.

Next, find out how the secondary is secured in its holder. Many scopes have a two- to four-vane spider but some have a single stalk holding the secondary in place. Check to see which your scope has and where the screws are that secure the secondary and its holder.

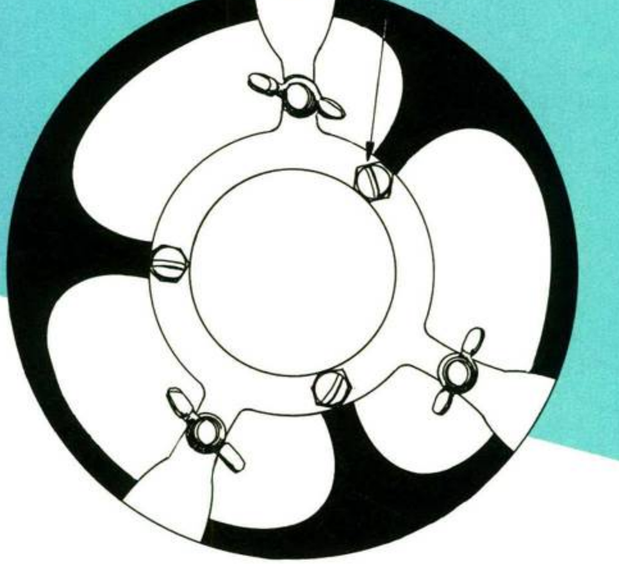
Take out the eyepiece and rack the focuser in as far as it will go. Now when you look into the empty focuser, you'll see an image of the primary mirror reflected in the secondary. Place the film canister in the eyepiece holder and peek through the hole. You'll see an image that consists of, from the outer edge to the center, the bottom edge of the focusing tube, the secondary mirror, the reflection of the primary mirror, and the reflection of the secondary mirror.

Your first job is to center the secondary so that it shows a reflection of the entire primary mirror. Loosen the screws holding the secondary and gently move the secondary in its holder so that you can see the primary and the clips that hold it in its cell. Move the secondary until this image appears centered in your sighting device. Once this is accomplished, tighten down the screws gently.

Now that the secondary is positioned, let's turn to the primary. At this point when you look into the sighting device, the image of the primary should appear to be centered in the actual secondary. But is



IN A NEWTONIAN TELESCOPE light bounces off the primary mirror and reflects into an eyepiece by means of a secondary mirror at the front of the telescope. Art by Phil Kirchmeier.



NEWTONIAN MIRROR CELLS feature three adjusting screws that enable you to tilt the mirror so it is in perfect collimation.

the image of the secondary and the spider centered in the primary? Probably not. This is where the screws on the main mirror cell come in. Using these screws, adjust the primary mirror alignment until the image of the secondary and the spider vanes are centered in the reflection you see in the sighting device. The optics are now roughly collimated.

Star Testing for Precise Collimation

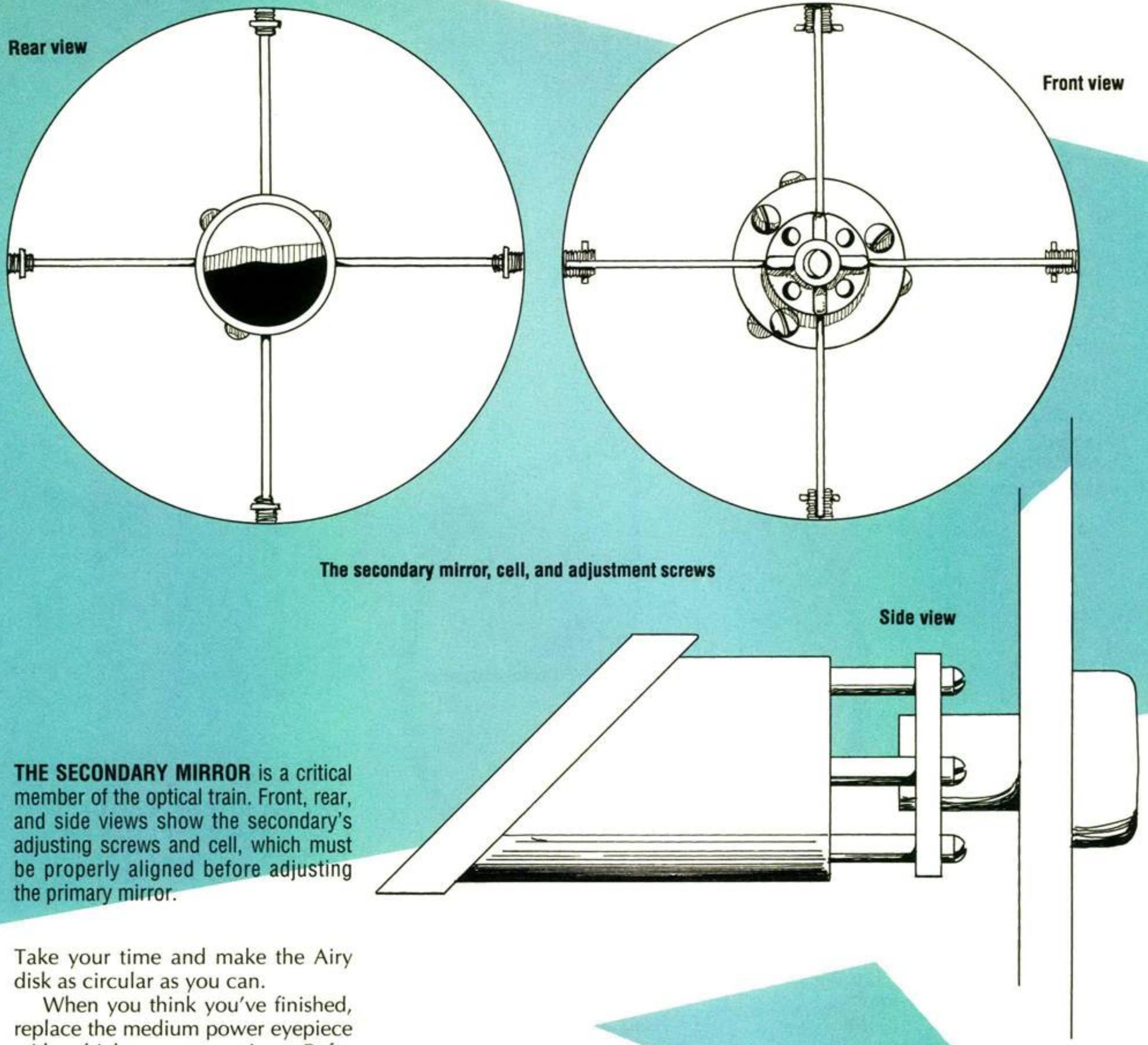
Precision collimation is slightly more demanding. The preferred method for final alignment is the star test, which will tell you how much to adjust your telescope to bring it into collimation and what, if anything, is wrong with your telescope's optics. After nightfall on a clear evening, take your scope out, let it cool down, and insert a moderate power eyepiece.

Locate a bright star, perhaps a second magnitude sparkler near the zenith. Center the star in your field of view and rack it out of focus. You want to place your eye outside the focal plane, so rack the focuser toward you. As you move the star out of focus, you'll notice that the star assumes a disk shape, called the star's Airy disk. The Airy disk is composed of a series of concentric bright and dark rings that should be circular and look like a tiny bull's eye. If the disk is a bit lopsided, you will have to use the adjustment screws at the back of the mirror cell to change it to a precisely round shape. Running back and forth between the focuser and the back end of the scope can get tiring, so if possible get a friend to help you. What you want to do is collimate the telescope so that the dark hole you see in the disk on both sides of focus is precisely centered within the out-of-focus star image.

After collimation, incoming light travels a straight path from the primary mirror to your eye.

At the outset, you will probably see that the rings in the Airy disk are a bit off-center. You'll need to determine which screw to turn and which way to turn it by trial and error. As you begin, make the adjustments to the screws very slowly. A twist that takes the adjustment screw through 360° may only send the image out of the field and frustrate you. Only very slight adjustments are necessary.

Try to determine the direction of the long axis of the Airy disk and turn the screw so that the image becomes more circular. As you change the disk into a bull's eye, the image is going to move from the center of the field of view. With each adjustment, no matter how slight, you will have to reposition the image in the center of the field.



The secondary mirror, cell, and adjustment screws

THE SECONDARY MIRROR is a critical member of the optical train. Front, rear, and side views show the secondary's adjusting screws and cell, which must be properly aligned before adjusting the primary mirror.

A star test tells you precisely how much to adjust your telescope to bring it into perfect collimation.

Take your time and make the Airy disk as circular as you can.

When you think you've finished, replace the medium power eyepiece with a high power eyepiece. Refocus the image (but not completely into focus) by moving your eye closer to the focal plane. Check it carefully. Using the high power eyepiece will allow you to further refine the shape of the Airy disk until you get it as close to a circle as possible. Once you've finished, you should be able to snap the image into focus and see a pinpoint star image. Congratulations, you're finished!

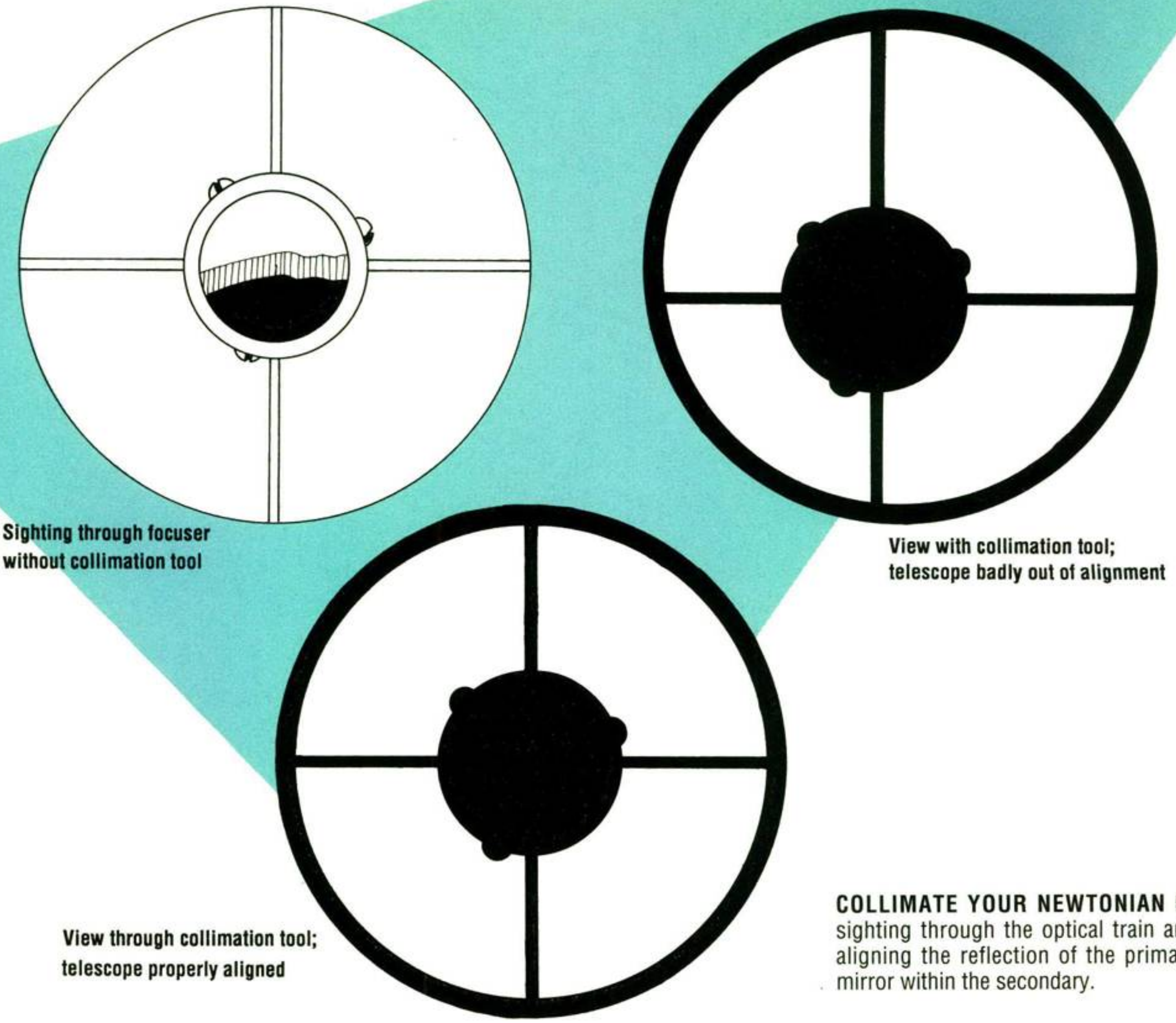
Unless your telescope gets bumped around a lot, the collimation you just performed should last a long time. However, it's not a bad idea to give your scope a quick star test before each observing session, or at least at periodic intervals.

Collimating Your Schmidt-Cassegrain

Another popular type of telescope is the Schmidt-Cassegrain Telescope (SCT). As with the Newtonian, the heart of this scope is a primary mirror and a secondary. But unlike the Newtonian's main mirror, the SCT's primary is permanently aligned at the factory and the only way to collimate the optics is by adjusting the secondary, which is attached to the back of the telescope's front-mounted corrector plate.

Begin your SCT collimation by examining the secondary mirror. You'll see three small screws or hex nuts oriented 120° from each other. (On some models these screws may be covered by a piece of plastic you will have to gently pry off.) These are the adjustment screws you must use to collimate the scope. In the center of this group there may be another, larger, screw or nut. That holds the secondary in its cell and you don't want to touch it!

To collimate your SCT, take it out under a clear sky, remove the star diagonal, and insert a medium power eyepiece. Locate a second-magnitude star near the zenith and throw it out of focus. As the star im-

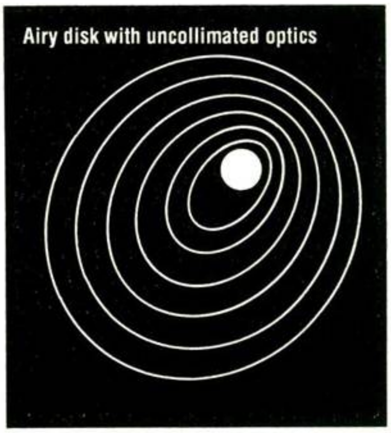


Sighting through focuser without collimation tool

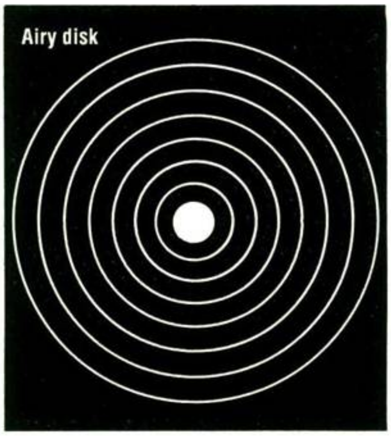
View with collimation tool; telescope badly out of alignment

View through collimation tool; telescope properly aligned

COLLIMATE YOUR NEWTONIAN by sighting through the optical train and aligning the reflection of the primary mirror within the secondary.



POOR ALIGNMENT shows this out-of-focus star as an elongated blob of an Airy disk.



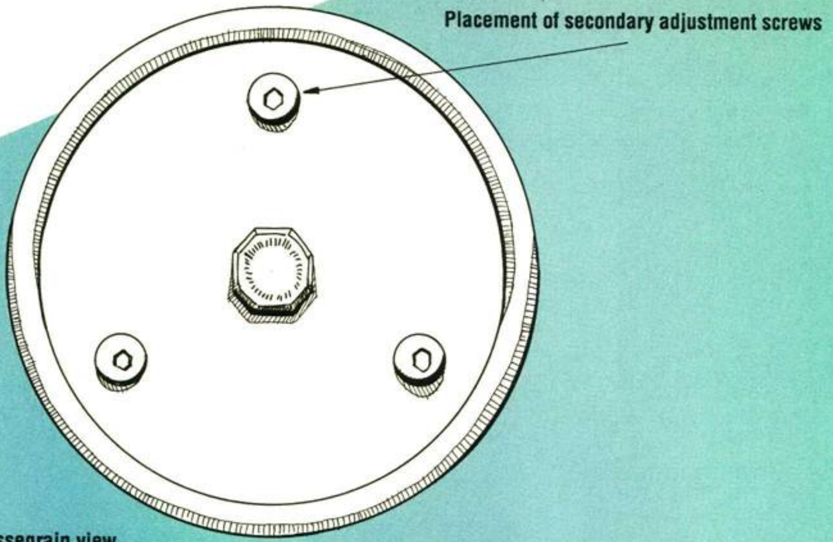
SUPERB ALIGNMENT shows the Airy disk as a perfectly concentric, circular "bulls-eye."

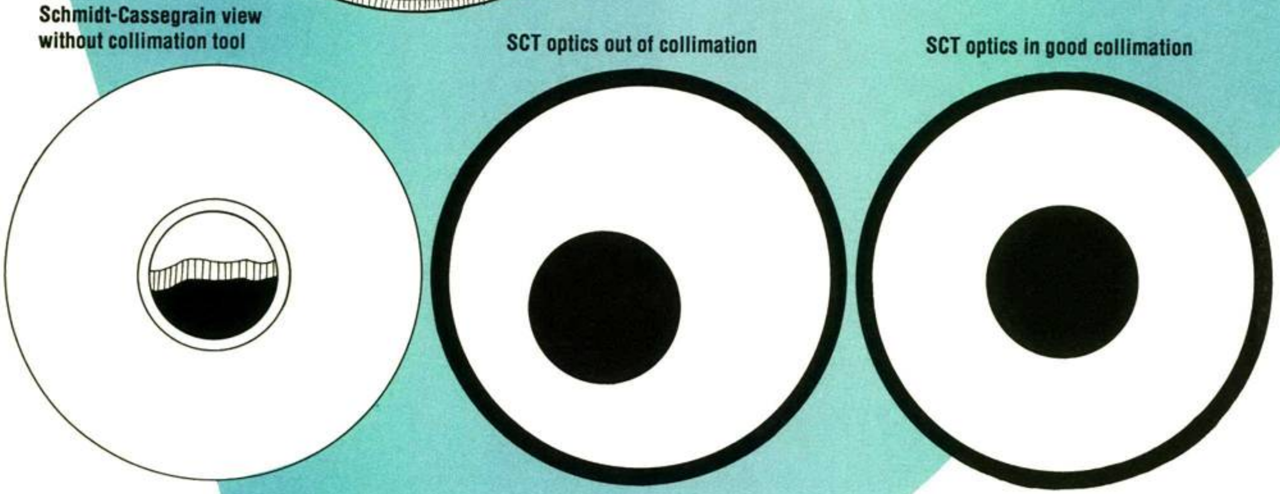
age expands, you will see the Airy disk expand to a bright disk with a dark center. Right now we want to do a rough collimation of the scope and we'll ignore the Airy disk and its rings for the time being.

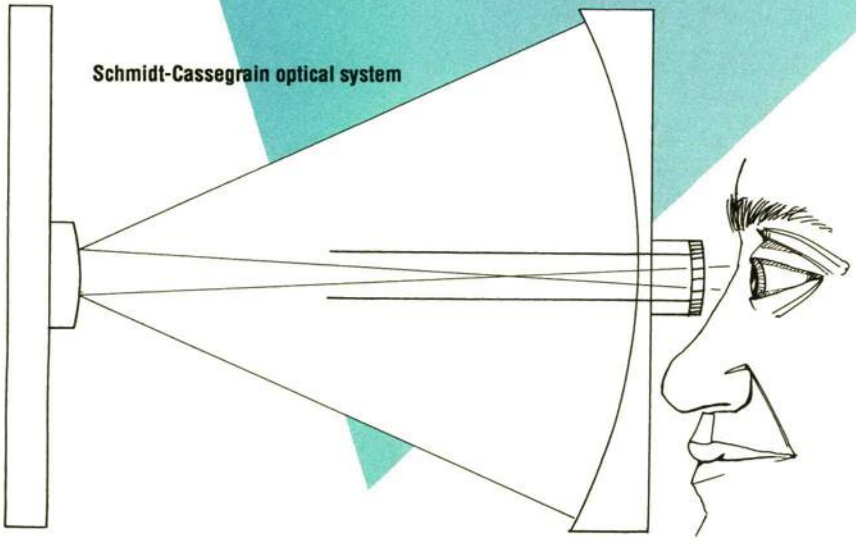
The disk is the out-of-focus image of the star, and the dark center is the silhouette of the secondary. Is the dark spot centered in the bright disk? If it's not, see where in the bright disk the spot is located and make the adjustment by turning the screw that most closely corresponds to the dark spot's position. As with the Newtonian, continue this until the dark spot is centered in the bright disk. Again, each movement of the adjustment screws will move the image you are looking at across the field of view, so take your time, make slight turns, and re-center the image after each adjustment.

Next, replace the medium power eyepiece with a high power eyepiece and re-center the star you have been using. Bring the star out of focus until you can see the Airy disk and its rings. Fine tune the collimation by turning the adjustment screw until the Airy disk looks perfectly circular.

Why worry about all of this? Well, here's one tale that should inspire you. A friend recently finished work on his pride and joy, a 20-inch Newtonian. Initially disappointed with the images it gave, particularly those of the planets, he spent a few nights pondering his problem and playing with the collimation of the instrument. Then everything fell into place, he reports,


Placement of secondary adjustment screws


Schmidt-Cassegrain view without collimation tool
SCT optics out of collimation
SCT optics in good collimation


Schmidt-Cassegrain optical system

SCHMIDT-CASSEGRAIN TELESCOPES are collimated by adjusting the screws on the secondary mirror. When in collimation, as in the final figure in the sequence above, the dark "hole" will appear precisely centered in an out-of-focus star.

and "once the scope was properly collimated, the views were spectacular! It was like using a totally different telescope."

A telescope is a precision optical instrument, one you have probably put a lot of time, effort, and money into obtaining. So it's in your best interest to get the most satisfying images you can from it. Make your hobby and the dollars you've spent for equipment pay off by collimating your telescope properly. It's the single most important step you can take to ensure sparkling, razor-sharp views of distant galaxies and colorful planets and stars. Following the instructions discussed above is a mighty small price to pay. Besides at the next star party, you can tell others how to collimate their scope and obtain clearer images, too. ☐

Michael Porcellino is an amateur astronomer living in Chicago, Illinois. His last article for ASTRONOMY was "How to Clean a Mirror" (March 1992 issue).

Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery, competitive prices.

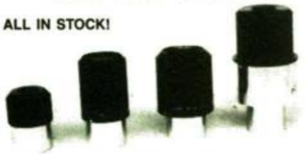
LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH

Barred Spiral Galaxy NGC 1300 in Eridanus. Photo by David Healy using a Lumicon Giant EASY-GUIDER and hypersensitized 2415 film. 1 hour exposure, Celestron-14 at f/[illegible].

TELE VUE™ EYEPIECES USE THE BEST!!

ALL IN STOCK!



Genesis 4" f/5 4 element fluorite	$1560
Pronto 70mm f/6.4 refractor w/2" diagonal	$689
Complete Equatorial Mount	$795
Motor Drive for above mount	$198
7.4, 10.4, 13, 17, 21, 26mm Plossl 50°	$89
1.8x or 2.5x Tele Vue Barlow Lens	$89
2" Giant Barlow - 2x	$219
32mm Plossl, widest true field in 1¼"	$109
55mm 2" Plossl, widest possible field	$219
15mm Wide-Field, 1¼" eyepiece, 65°	$135
19mm Wide-Field, 1¼" eyepiece, 65°	$145
24mm Wide-Field, "superb," 65°	$169
32mm Wide-Field, 2" eyepiece, 65°	$239
40mm Wide-Field, "awesome," 65°	$299
4.8mm Nagler, 82° field	$149
7mm Nagler, 1¼" eyepiece, 82° field	$189
9mm Nagler, 82° field, "the best"	$219
11mm Nagler, 82° field, 1¼" or 2"	$235
13mm Nagler, 82° field, 1¼" or 2"	$249
12mm Nagler, Type II, 82°, 1¼"/2"	$249
16mm Nagler, Type II, 82°, 1¼"/2"	$289
20mm Nagler, Type II, 82°, 2" only	$340
1¼" Paracorr Visual Coma Corrector	$179
2" Paracorr Visual Coma Corrector	$298
NEW! 22mm Panoptic 1¼"/2", 68°	$249
NEW! 35mm Panoptic 2", 68° field	$325

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

LUMICON Adjust. Piggyback Mount $59.50
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	H-Alpha	(MV)
46, 48, 49mm	$49.00	$39.00
52, 55, 58, 62mm	$59.00	$49.00
67, 72, 77mm	$69.00	$59.00
82mm	$79.00	N/A

Hypered 2415 film, 36 exp .. **$10.95, $3/$29**

LUMICON®

2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (510) 447-9570
FAX (6 PM-9 AM PST) (510) 447-9589
LUMICON Products catalogue FREE
All foreign orders add 6% ($8 minimum)
California residents add 8.25% tax.
Prices subject to change w/o notice.
Hrs: M-F 9 am - 5 pm, Sat. 11 am - 3 pm

NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" **$29.95** 1.52" **$34.50** 1.83" **$39.50**
2.14" **$49.50** 2.60" **$65.00** 3.10" **$89.50**

ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror)	**$99.50**
2" (1.83" mirror)(see photo above)	**$159.00**

LUMICON FILTERS — BEST IN THE WORLD!

"The LUMICON OIII proved to be our favorite... It gave the greatest contrast gain."
ASTRONOMY February 1991

AMAZING OIII FILTER™

Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90% for both O-III lines at 496nm and 501nm.

"I CAN SEE THE VEIL NEBULA!"

Rich Zepernick saw the Veil Nebula for the very first time with a **LUMICON UHC Filter**. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*
Rich Zepernick, Cresskill, NJ

SEE THE HORSEHEAD!

Horsehead Nebula in Orion. This faint nebula is seen best with a LUMICON H-Beta Filter. Photo by J. Marling using a Deep-Sky Filter.

DEEP-SKY FILTER™

BEST for Astrophotography!

"Stunning is all I can say," says noted astrophotographer Jack Newton. *"Great for BOTH color and black and white photography."*

BEST WIDE-BAND FILTER!

"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complimentary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for ***reflection*** *nebulae."*
Astronomy, Feb. 1991

	Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces	$59.50
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces	$79.50
48mm LUMICON DEEP-SKY Filter (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	$119.50
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	$119.50
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)	$299.50
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces	$99.50
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	$199.50
Set of both premium **DEEP-SKY** and **UHC Filters** (Save 11%) ... 1¼" **$159.50**; 48mm	$279.50
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"** **$99.50, 48mm**	$199.50
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines .... **1¼" $99.50, 48mm**	$199.50
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm	$6.95
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece	$16.00
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece	$20.00

**Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

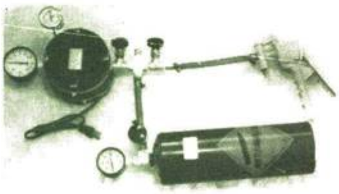
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**



MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

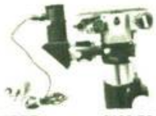
Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$325**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™



Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	**$169.50**
3X Relay Diagonal (see photo)	**$89.50**
Illuminated reticle eyepiece system	**$99.50**

Guider for Hasselblad **$350,** Mamiya 645 **$199**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$198,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ...... **add $99.95**
Adapter for Hasselblad **$229,** Mamiya 645**$129**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector . $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.

Declination motor (state telescope) .. $99
NEW Deluxe Digital Qtz. Drive Correc. **$298**

Kodak
SR 1600
Scotch
Scotch
1000

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).***No C.O.D.s.***

Film Type, 35mm	Exposures	Price
2415, Ultra-fine B&W, red sens.	36	$10.95
SR-G3200, fastest of all, color neg	24	$13.95
Kodak Ektar 1000 fast, fine grain	24	$12.95
Fuji HG400 fine grain color neg.	12	$10.95
3M 1000, fastest slide film	12	$12.95
Fujichrome RD100, fine grain slide	24	$12.95
D-19 B&W Developer	1 gal.	$6.95

NEW MEADE® ADVANCED PRODUCTS AT LUMICON

"What an astounding combination of high performance and low price!" Jack Marling, Ph.D., owner of LUMICON

TOLL-FREE ORDER LINE 1-800-878-9577 EXPERT INFORMATION 1-510-447-9570 FAX 1-510-447-9589

NEW ED APOCHROMAT REFRACTORS

6'' f/9 Aprochromat

Only $3995

New Meade 6'' f/9 Model 152ED Refractor shown with #1697 Computer Drive System.

See the Meade ad in this magazine for full specifications and product descriptions. ED = Extremely low dispersion glass which yields color-free virtually perfect images. PPEC = Permanent Periodic Error Correction "Smart Drive."

Model 102 ED 4'' f/9 Apochromat and mount	$1795
Model 127 ED 5'' f/9 Apochromat and mouqt	$2295
Model 152 ED 6'' f/9 Apochromat and mount	$3995
Model 178 ED 7'' f/9 Apochromat and mount	$4995

DRIVE SYSTEMS

#1664 Electronic Drive with PPEC and 2X, 32X slewing system, dual-axis controller	$295
#1697 Computer Drive, 747 object computer memory, automatic slewing to desired object	$595
8,000 object library of deep-sky targets	add $99

OPTICAL TUBE ASSEMBLIES (OTA)

Model 102 ED/OTA 4'' f/9 OTA only	$1075
Model 127 ED/APO-OTA 5'' f/9 OTA only	$1595
Model 152 ED/APO-OTA 6'' f/9 OTA only	$2295
Model 178 ED/APO-OTA 7'' f/9 OTA only	$2995

EQUATORIAL MOUNTS

LXD 600 mount and standard field tripod	$895
LXD 700 mount and giant field tripod	$1995

NEW MEADE LX100 & LX200 SCHMIDT-CASSEGRAIN TELESCOPES

8'' LX200

$1995

NEW MEADE 8'' LX200 TELESCOPES

See the Meade ad in this magazine for full specifications and detailed product descriptions.

LX100 Drive, 2X, 32X speed control with PPEC (Permanent Periodic Error Correction "Smart Drive") and dual-axis hand controller.

LX200 Drive, Full electronic control with PPEC, 747 object computer memory and automatic computer controlled slewing to desired object.

NOTE: A wedge is **not** needed for visual observing with the LX200 Drive. Specify f/6 or f/10 optics at the *same* price.

8'' LX100 Schmidt-Cassegrain with wedge	$1695
8'' LX200 Schmidt-Cassegrain with computer	$1995
Wedge for photographing with LX200	$110
10'' LX100 Schmidt-Cassegrain with super wedge	$2395
10'' LX200 Schmidt-Cassegrain with computer	$2295
Super Wedge for photography with LX200	$395

OTHER SCHMIDT-CASSEGRAINS

Meade 2045D 4'' f/10 with motor drive	$695
Meade 2080B 8'' f/10 with tripod, wedge, MCOG	$1175
NEW! Model 2120B 10'' f/10 with wedge, tripod, MCOG	$1595

PHOTOGRAPHY ACCESSORIES

LUMICON Cassegrain EASY-GUIDER f/6 or f/10	$225
Cassegrain EASY-GUIDER for f/6.3 8'' telescope	$195
LUMICON Giant EASY-GUIDER for 10'' f/5-f/10 operation	$395
Giant EASY-GUIDER for f/6.3 10'' telescope	$295

MEADE STARFINDERS

8'' f/6

$599*

New 8'' f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions and technical specifications for 6'' to 16'' Starfinders. These are complete telescope systems with motor drive, mount, finderscope and 48X eyepiece.

6'' f/8 Starfinder 6(add $50 shipping)	$499
8'' f/6 Starfinder 8 (add $60 shipping)	$599
10'' f/4.5 Starfinder 10 (add $75 shipping)	$699
16'' f/4.5 Starfinder 16 (ship. freight COD)	$1995

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated shipping charge to the price. LUMICON showroom prices are $96 higher.

ACCESSORIES

LUMICON carries the full line of Meade accessories. See the Meade ad in this magazine for detailed prices and descriptions.

Meade #43 Single axis drive corrector	$99
LUMICON DX200 Dual-axis drive corrector	$249
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack	$299

LUMICON® SKY VECTOR™

Higher Performance — Lower Price

LUMICON ACCESSORIES

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550 (510) 447-9570 FAX (510) 447-9589

SKY VECTOR $399

NEW! With over 200 object memory including the 110 Messier objects.

SKY VECTOR II™ $499

Only the LUMICON SKY VECTOR II has size, **true visual magnitude**, and complete **detailed visual description** for **all** 1500 objects in memory.

NGC SKY VECTOR™ $699

IMPROVED!—1731 Additions / Corrections

NGC-Sky Vector
LUMICON

Improved NGC SKY VECTOR with over 8,000 object memory including complete and corrected RNGC catalogue, and IC and planetary catalogues.

LUMICON NGC SKY VECTOR FEATURES:

- All features of LUMICON SKY VECTOR II
- Complete *corrected* RNGC catalogue
- 574 nonexistent NGC objects identified
- 343 corrections to RNGC catalogue
- 203 best colored & multiple stars
- 140 "Best IC Objects" catalogue
- 306 best planetary nebulae selected by Jack Marling in separate catalogue listing
- 268 best "Non NGC / IC" objects catalogued
- "IDENTIFY" program helps you identify an unknown object seen in eyepiece
- "GUIDE" program leads you to object
- Detailed visual or photographic descriptions
- RS-232 port for computer access
- Includes planets' ephemerides in computer

Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR

Coma 1 inch off-axis 17½'' f/4.5

Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2'' lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2'' EASY-GUIDERS for effortless installation.** This lens is optimized for f/4.5 and reduces aberrations for f/3.5 to f/5 Newtonians. Off-axis images are much smaller, making off-axis guiding far easier and yielding round pinpoint star images in photos. Since star images are sharp over a full 2¼'' circle, you can use medium format cameras in addition to 35mm cameras. This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Although designed for photography you may also use this lens to improve image quality in wide-field viewing with low power eyepieces. Clear aperture = 1.8''.

LUMICON Coma Corrector/Field Flattener Lens	$285.00
LUMICON 2'' EASY-GUIDER	$169.50
2'' EASY-GUIDER (Mamiya 645)	$199.50
2'' Adapter for Pentax 6x7	$85.00
2'' Adapter for Hasselblad	$185.00
2'' Adapter for Bronica SQ-A	$175.00
2'' Extension for viewing	$26.00

2'' DELUXE BARLOW

1.8x Multiplier Lens (2'' Barlow)

The computer-designed LUMICON 2'' Multiplier/Field Flattener multiplies the image scale in photography by 1.8x (f/4.5 becomes f/8). Use it with any LUMICON 2'' EASY-GUIDER. Guide-stars also become much sharper to make guiding easier. This lens is optimized for f/4.5, but will work well with any optical system. It may also be used visually as a highly corrected 2'' Barlow lens.

LUMICON 1.8x Multiplier Lens (2'' Barlow)	$235.00

NEW! LOW PROFILE HELICAL FOCUSERS

FROM $59.50

LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½'' above the telescope tube. Use the 1¼'' or 2'' versions for viewing. Use the 2'' non-rotating focuser for convenient photography with the LUMICON 2'' EASY-GUIDER™.

Select your desired base-plate shape! Flat, 7'' OD, 9½'' OD, 12½'' OD, 16'' OD, 21'' OD.

LUMICON 1¼'' Helical Focuser	$59.50
LUMICON 2'' Helical Focuser 1½'' high	$65.00
LUMICON Non-rotating Helical Focuser	$89.50
2'' rack & pinion focuser, only 2'' high	$139.00
3 handles for non-rotating focuser	$12.95
2''/1¼'' adapter w/48mm filter threads	$20.00
2'' LUMICON EASY-GUIDER	$169.50

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼'' 50mm Finderscope **$59.50**, right-angle	$89.50
1¼'' straight-thru 80mm SUPER-FINDER	$169
1¼'' right-angle 80mm SUPER-FINDER	$179.50
1¼'' right-angle version, w/star diagonal	$209
25mm Cross-hair 1¼'' eyepiece (12X)	$39
1¼'' Star Diagonal **$39**, Mounting Brackets,	$37
1¼'' Amici Prism diag. for correct left-right views	$69.50

2'' ADAPTERS MEADE, CELESTRON TELESCOPES

These adapters convert refractors and Schmidt-Cassegrain telescopes for 2'' operation. They allow use of 2'' accessories, such as the LUMICON 2'' EASY-GUIDER for photography. They also allow use of 2'' eyepieces and/or 2'' star diagonal for viewing.

2'' adapter for C-8, Meade 2080, etc.	$26.00
2'' adapter for C-80, C-100 refractor	$39.50
2'' adapter for C-70, C-80F, C-90F, C-100F	$39.50
2'' Accessory adapter for Comet Catcher, C-6, Meade 312, 321 refractor	$30.00
2'' LUMICON EASY-GUIDER (state camera)	$169.50

RING OF FIRE

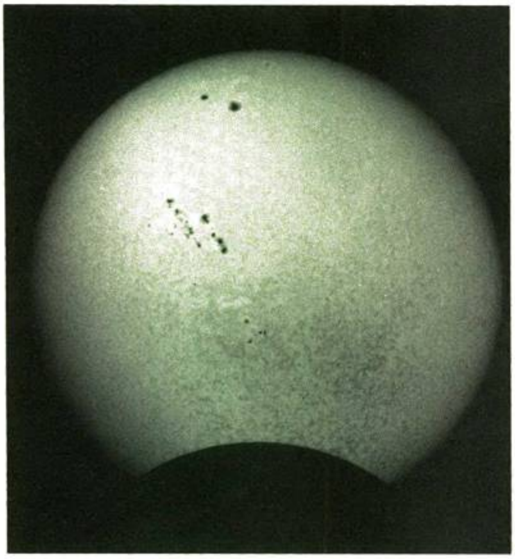
For those lucky enough to find clear skies, January's annular eclipse provided a spectacular start to the new year.

by Richard Talcott

"The Sun looks like it has a hole in it!" exclaimed Annmarie Garfinkle. Five-year-old Annmarie, a veteran of last July's eclipse, was one of literally millions of people in the San Diego area who witnessed the January 4 solar eclipse.

But not everyone was so fortunate. The entire Los Angeles metropolitan area, where many eclipse chasers had set up shop, was clouded out during annularity. Observers were up against a huge Pacific storm boring in from the northwest. Though skies remained clear until early afternoon, by eclipse time the leading edge of the storm had pushed into Los Angeles.

Fortunately the storm held back long enough that areas south of Los Angeles had partly cloudy to clear skies throughout the eclipse. Spotty, low clouds interfered somewhat with annularity from about Laguna Beach south to Oceanside, and the coast was mainly clear from Oceanside south.

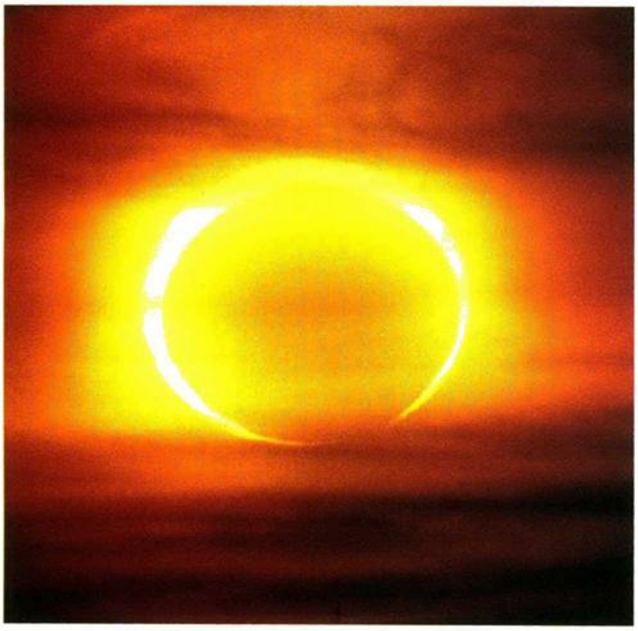


INTRICATE BANDS OF SUNSPOTS greeted observers with telescopes during the early stages of the January 4 eclipse. H-alpha photo by Bob Yen.

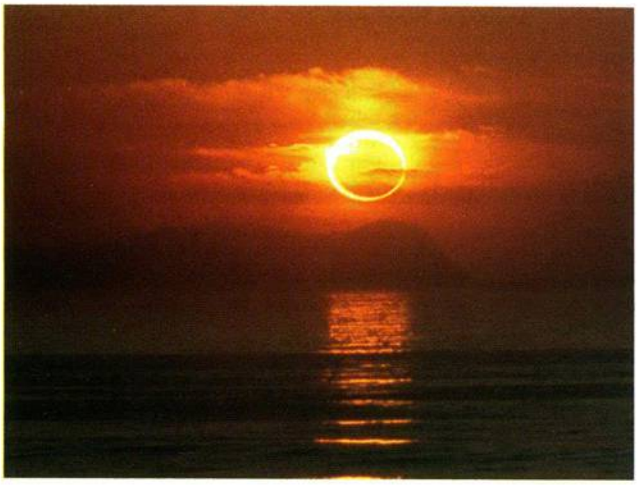
AN OVAL RING OF SUNLIGHT shone through patchy clouds in San Diego, where Phil Lohmann captured the eclipse shortly after second contact.

SUNLIGHT GLITTERS off the ocean water as two eclipse viewers await annularity. Photo by Dewey Vanderhoff.

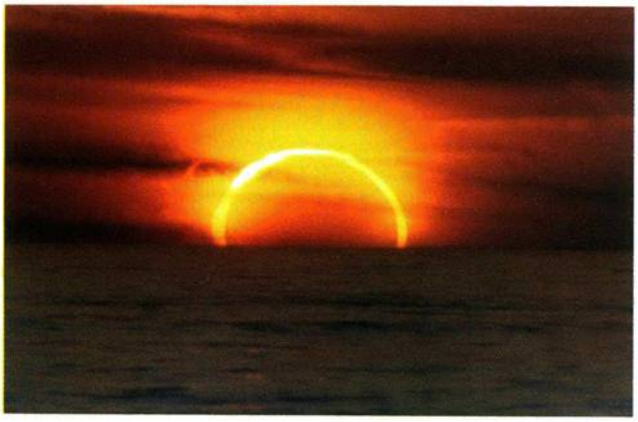
CLOUDS INTERFERED with some views of the eclipse, but they did provide a stunning foreground for Patrick Macnamara's photo.



SECONDS AFTER SECOND CONTACT, Steve Edberg snapped this picture of the centrally eclipsed Sun.



THE ECLIPSED SUN POSES just above the Coronado Islands as seen from Tijuana, Mexico. Photo by Jorge Soto.



QUENCHED BY THE COOL PACIFIC, the "ring of fire" sinks out of view for photographer Alan Nelson.

ONLOOKERS GAZE at the sinking Sun just after annularity began. Photo by Tony Dunn.

Most eclipse watchers chose to view the event with the naked eye, though a few brought along telescopes. They were the ones who saw an unusual pattern of sunspots before the eclipse and during the early partial phases. Bob Garfinkle (Annmarie's father) described it as "beautiful bands of sunspots that appeared in the area of the Sun's equator. Most of the spots were located on the eastern half of the Sun, with a large spot near the eastern limb."

But sunspots are an everyday occurrence. The real excitement built as the Moon pushed farther and farther onto the Sun's disk. The Moon was quite far from Earth during this eclipse, so it didn't appear large enough to cover the Sun completely. Instead a ring of sunlight, or annulus, remained visible around the Moon at maximum eclipse. Because southern California was at the end of the eclipse track, the eclipsed Sun set into the Pacific Ocean just at the moment of maximum eclipse.

Most people didn't know what to expect as the Sun plunged into the ocean. One who was willing to travel a long way to find out was Dewey Vanderhoff of Cody, Wyoming. He drove 1,300 miles to view the eclipse and wasn't disappointed in the least. "It was spectacular. We were located on a bluff 360 feet above sea level at Torrey Pines State Park near San Diego, where we saw the eclipse with a few hundred other people. To see the ring of fire set on the rim of the Pacific Ocean from a beautiful location is all a skywatcher can hope for."

Steve Edberg and Jay Anderson got all that, plus a little more. As they watched the Sun disappear into the ocean, they eagerly awaited the sight of a "green flash" — a glimmer of green light seen occasionally as the last rays of sunlight refract through our atmosphere. They weren't disappointed. Both saw an intense green flash, though it proved elusive — a group of observers 30 feet below them did not see it at all.

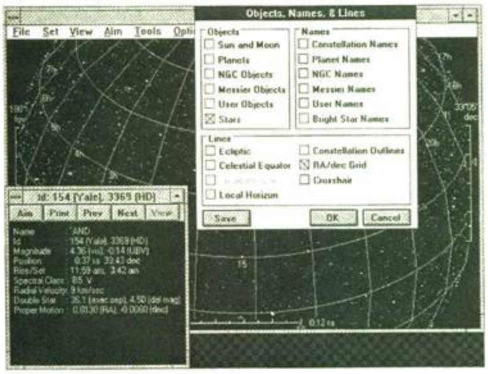
Then the Sun was gone. Edberg saw the Moon's shadow receding to the east and then — darkness. Twilight was essentially nonexistent because the Sun, after it dropped below the horizon, was still mostly covered by the Moon. The sudden end to the day found many eclipse watchers thinking ahead to the next annular eclipse, which will cut a wide swath across North America on May 10, 1994. Though that one promises to be sensational too, it will have a way to go to equal California's sunset eclipse. □

Who Needs Windows?

You Don't, If You're Using

STARGAZE

Windows



Objects, Names, & Lines

Objects
☐ Sun and Moon
☐ Planets
☐ NGC Objects
☐ Messier Objects
☐ User Objects
☒ Stars

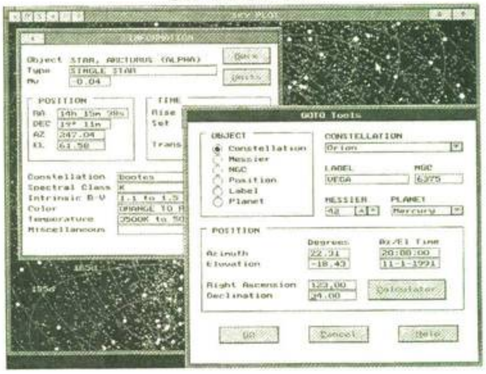
Names
☐ Constellation Names
☐ Planet Names
☐ NGC Names
☐ Messier Names
☐ User Names
☐ Bright Star Names

Lines
☐ Ecliptic
☐ Celestial Equator
☐
☐ Local Horizon
☐ Constellation Outlines
☒ RA/dec Grid
☐ Crosshair

id: 154 [Yale], 3369 [HD]

Name : AND
Id : 154 [Yale], 3369 [HD]
Magnitude : 4.36 [vis], -0.14 [UBV]
Position : 0.37 ra 33.43 dec
Rise/Set : 11:59 am, 3.42 am
Spectral Class : B5 V
Radial Velocity : 9 km/sec
Double Star : 35.1 [asec sep], 4.50 [del mag]
Proper Motion : 0.0130 [RA], -0.0060 [dec]

STARGAZE



Object STAR, ARCTURUS (ALPHA)
Type SINGLE STAR
Mv -0.04

POSITION
RA 14h 15m 39s
DEC 19° 11m
AZ 247.04
EL 61.50

TIME
Rise
Set
Trans

Constellation Bootes
Spectral Class K
Intrinsic B-V 1.1 to 1.5
Color ORANGE TO R
Temperature 3500K to 50
Miscellaneous

OBJECT
● Constellation
○ Messier
○ NGC
○ Position
○ Label
○ Planet

CONSTELLATION Orion
LABEL VEGA
NGC 6375
MESSIER 42
PLANET Mercury

POSITION
Degrees
Azimuth 22.31
Elevation -18.43
Az/El Time 20:00:00
11-1-1991
Right Ascension 123.00
Declination 34.00

Over 500,000 Stars + Selected Hubble Guide Star Data to 16Mv + High Resolution Printouts up to 35 ft. + 2 Projections + Planet Animation + Create Your Own Databases and Labels + 8 grid spacings + Runs Under Windows as a DOS Application and Includes a Windows Icon + Runtime Decompression of Data + Print Utility for Batch Processing + Slide Show of the Constellations + Moon Phase Calenders and MORE!!!!

By the way... It's Only $149.95 + $5.00 S&H 3.5" HD Disks

Competetive Upgrades and Other Discounts Available

FREE BROCHURE (800)232-7830 or (805)499-0958

CEB Metasystems, Inc
1200 Lawrence Dr. #175
Newbury Park, CA 91320

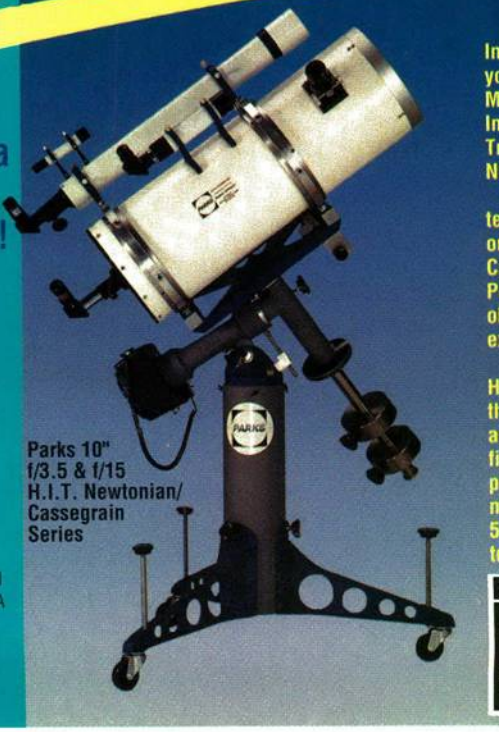
Requirements: IBM PC,AT,PS/2; 640K RAM; Hard Disk; EGA/VGA; Mouse; Coprocessor RECOMMENDED: Exp 6/1/1992 Windows TM Microsoft

---

Parks Presents

The Ultimate Telescope!

Introducing the all new H.I.T. Series, featuring a Newtonian/ Cassegrain f/3.5 & f/15 dual system! Available in 6", 8", 10", 12½" & 16" telescopes.



Parks 10" f/3.5 & f/15 H.I.T. Newtonian/ Cassegrain Series

Imagine... the f/3.5 richest field telescope. Imagine observing the Veil Nebula... feasting your eyes on North American Nebula including Mexico and the Pelican in one field of view. Imagine viewing M81 and 82, or the Lagoon and Trifid or the entire belt of Orion or M31, M32 and NGC 205 all at once.

Now take a few moments and switch your telescope to an f/15 and imagine seeing details on the moon to the size of a city block. See Casini division and Crepe Ring of Saturn, or the Polar Caps and Olympus Mons on Mars. Imagine observing the Great Spot and Festoones extending from the belts of Jupiter.

Parks proudly introduces the state-of-the-art H.I.T. telescope series. Featuring, as always, the highest quality components; precision crafted and assembled in-house. Also included are hand figured and certified fine annealed low expansion pyrex mirrors, genuine fiberglass tubes, dual axis motors and drive corrector, two Gold Series 1¼" 5 element eyepieces and more... the telescope of tomorrow... available today!

Telescope	Foc. Lngth@f/3.5	Foc. Lngth@f/15	Factory Direct
6"	550 MM	2,300 MM	$1,999
8"	700 MM	3,000 MM	$2,299
10"	900 MM	3,800 MM	$3,399
12½"	1100 MM	4,800 MM	$5,299
16"	1400 MM	6,100 MM	$15,500

PARKS OPTICAL
270 EASY STREET
SIMI VALLEY, CA 93065
Info: (805) 522-6722

ORDERS ONLY:
Nat'l (Except CA) (800) 44-PARKS
In CA (800) 43-PARKS

Add 3% ($5.00 Min.) for shipping, handling & full insurance. Oversized items ship freight collect. CA residents add 6% sales tax. FREE COLOR CATALOG (foreign USD $5). Parks Optical is not opened to the public. Merchandise available through mail order or at any authorized Parks dealer worldwide.

"CLIP AND SAVE"

$895
SUPER C8
POLARIS

BAUSCH & LOMB
8000 8" f10 **$649**
6000 **$599**

MEADE 2080 AC/DC $979

DELUXE

2080 + WEDGE TRIPOD $899

MEADE — CELESTRON — BAUSCH & LOMB — BUSHNELL — TUTHILL — LEICA
BRANDON/VERNONSCOPE — UNIVERSITY OPTICS — JASON — VOGEL/DIGITRACK
TECTRON — DAVIS & SANFORD — J.M.I. — KOWA — FUJINON — STEINER
ADLERBLICK — 1000 OAKS — NIKON — SWIFT — EWA — EDMUND — JENA
TASCO — VIXEN — PARKS — LOSMANDY — ZEISS — MINOLTA — ETC.

* CALL FOR BEST PRICES PHONE ORDERS 7 DAYS – 10 AM - 10 PM

CELESTRON

TELESCOPES

C14	$5500
COMPUSTAR C14	$8999
C11 Ultima (PEC) with DEC/Focus Motors	$3195
Ultima 8 (PEC) with Focus DEC Motors	$1949
SPC8	$895
SPC8 w/Starbright	$1124
COMPUSTAR 8	$2599
POWERSTAR (PEC) C8	$1529
CLASSIC 8 (w/Wedge) & STAR BRIGHT, Tripod	$1099
C040 Refractor, Tripod (2) Eyepieces	$69
60mm Alt-Azimuth Refractor (C60)	$114
(C60E) EQ REFRACTOR	$196
Firstscope 80 $454 (in brass)	$799
SP-C80	$606
Refractor (SP-C102)	$1039
Fluorite Refractor (SP-C102F)	$2119
Telephoto 500mm F5.6	$299
Telephoto 1000mm C90	$319
C4.5	$428
SPC6	$719

SPOTTING SCOPES

C-90, C90 M/C, C90 M/C Armored C90 1¼" Format — All in Stock	From $333
C60R $219 C65	$189
Fluorite Spotting Scope SS55F	$609
SS80	$335
Photographic Tripod $94 Mini Tripod	$24
Shoulder Mount	$68

BINOCULARS

Monocular 8x25	$37
Mini Binoculars 8x25 $64 10x25	$84
Waterproof 7x50, 10x50 $195 7x50 Sport	$79
10x50 PRO $119 7x50 PRO $114 12x50 Pro	$129
Ultima 7x42, 8x32 $175 ea 8x56	$188
11x80 M/C $290 15 × 80 M/C $295 20x80 M/C	$299
30x80 $389 20x100	$975
Fixed Focus 8x40 WA, 7 × 50WA, 10 × 50WA	$64
BINOCULAR NECK STRAP (Wide)	$10
7x50 $65 Armored 10x50	$66

OPTICAL TUBE ASSEMBLIES

C80 C4.5	$279 ea
8" Optical Tube Assem	From $569
C11 $1849 C14	$3899

ULTIMA EYEPIECES

1¼" 5, 7.5, 12.5, 18, 24mm, 2x BARLOW	$62 ea
30, 35, 42mm	$86 ea
15, 19, 23mm WA	$102 ea
45, 60mm 2"	$159 ea
80mm 2"	$259
.96" OR 5, 6, 7, 9, 12mm	$36 ea
.96" KE 10mm, 18, 25, 30, 40	$29 ea
Zoom .96" OR 8.4-21mm	$62
25mm K 1¼ Multi-Coated	$35
Terrestrial Eyepiece .96"	$17
OR 1¼" 5, 6, 7, 9, 12, 18, 25mm	$45 ea
PL 1¼" 36mm, 45mm	$59
Zoom OR 1¼" 8.4-21mm	$100
18, 25mm OR 2" SPECIAL PURCHASE	$74
Coma Corrector, Photo-Visual 1¼"-2"	$175
Micro Guide Eyepiece	$135

T-RINGS

(State Camera Make-Model) All $10 EA (2) FOR $18	
2¼" Format	$159

ACCESSORIES

AC Adapter (PEC)	$25
Accessory Case	$40
Barlow Lens 2x .96"	$26 ea
Barlow Lens 2x 1¼"	$39
Barlow Lens 2x 2"	$94
Battery (Ill. Reticle)	$2.95
Binocular Tripod Adapter	$14
Car Batt. Adapter, Ultima (PEC)	$19 ea
Car Window Mount	$50
Carrying Case - Powerstar 8 Custom	$139
Counterweight Bar Assem. - 8" $94 11"	$98
Counterweight Set - 8" (Standard)	$48
DC Inverter (110V)	$74
Diag., Erect Image - 45° .96" $42 45°-1¼"	$46
45°-.96" to 1¼"	$45
DEC Motor - Powerstar, Classic 8	$92 ea
DEC Motor - 11"	$79
DEC Motor C8, Sup. C8, Classic 8	$99
DEC Motor (PEC) 8/11	$92
Deluxe Lat. Adjuster (DLA) C8	$30
Dewstar (Lens Shade - 8")	$25
Advanced Astro Master (Several Models)	From $489
Drive Corrector - Heavy-Duty $359 Quartz Sing. Axis	$144
Quartz Dual Axis	$243
Expanding Bushing - .96" to 1¼"	$14
Filter (All colors) 2"	$19 ea
Filters #1A, 8, 12, 15, 21, 23A, 25, 38A, 47, 56, 58, 80A, 82A 96ND-50%, 96ND-25%, 96ND-13%, Polarizing	$10 ea
Filter Sets (Set of 6) $59 (Set of 12)	$118
Filter — Series 5 or 6 (6 ea. in set)	$55
Filter Adapter - .96" $12 1¼"	$16
Finderscope 8x20 for C90-erect image $54 BKT	$12
Finderscope R/A 5x24 $39 5x24 STG $29 6x30	$29
8x50 $49 16x70 R/A w/pol. ill	$189
R/A w/Polar Align. Reticle - 8x50 Ultima w/BKT	$144
Focus Motor w/Hand Control Box — Ultima 8, Powerstar, Clas. 8	$99
Focus Motor - C8, Super C8, Classic 8	$85
Focus Motor (PEC) 8/11, 11/14	$99
MFFT 55	$129
Illum. Projection Reticle - 1¼"	$134
Image Corrector - 1¼" C90-C60-.96	$42
Large Accessory Ring (LAR)-C90	$21
Lens Shade - C90 $54 C8 $25 C11	$105
LPR Filter (Nebular) #2 $129, #3 $42 #5	$79
#7 $89, A $58, B $89, C $119 D $85	
Motor Drive - for C4.5, w/Dr. Single Axis - SP (DC)	$165 ea
Motor Drive S.A. (AC) Pol/Sp	$89
Motor Drive w/Dr. Dual Axis - SP (DC)	$253
Multiple Ocular Holder - .96" $68 1¼"	$134
Off Axis Guiding System $127 Guider Body (Only)	$59
Photo Tripod Adapter - 8"	$50
Photographic Tripod Deluxe Slow Motion Controls	$43
Piggyback Mount - 8" $33 11/14	$44
Piggyback Mount - SPC80, SPC102, SPC6	$39 ea
Polar Axis Finder w/illum. (for C4.5)	$54
Polar Axis Finder - SPC6 - C80	$66
Polar Filter Set-.96" $36 Polarizing Filter Set - 1¼"	$42
Porro Prism - .96" $39 Porro Prism - 1¼"	$39
Radial Guide Assy - Off Axis	$99
RFA (Rich Field Adap.)	$79
Refractor Accessory Ring	$18
Reducer/Corrector Lens f6.3	$135
Reducing Bushing = 1¼" to .96"	$16
Filter Set - Series 5 (six) $49 Series 6 (six)	$49
Skylight Filter Model #1 (C90's) $31 #2 (8/11/14)	$36
Solar Filter - C90 C102 C4.5	$65
Solar Filter - C8 $105 8" (C14)	$125
5" Off-Axis - C-11 $109 C60-C80	$42
Star Diagonal - .96"	$19
Star Diagonal 1¼" w/Multicoatings	$39
Star Diagonal (Mirror) 2"	$129
Star Diagonal 2" Multi-Purpose	$215
Stereo Binocular Viewer	$438
Super Polaris Half Pier	$105
Super Polaris Mt. & Tripod	$449
Telecompressor Lens f5 or f7.5	$39
2¼ Camera Adapter (specify 2¼ camera)	$149
T-Adapter (8/11/14) C-90, Zoom Master/C60	$22 ea
T-Adapter/Tele-Extender - Refractors, C4.5, C6	$32
T-C 16mm Adapter	$28
Table Top Mount - C65	$20
Tele-Extender $22 T-Adapter (Refractor/Newt.)	$38
Tripod - Adjustable 8" Armored	$205
C8 Tripod (D + S) $159 11/14	$468
V.S.P. (Vibration Suppression Pads)	$38
Visual Back - 1¼"	$26
Wedge-C8 $85 Heavy-Duty 8" $198 11/14	$369
Tilt Plate 0 Degrees	$59

PUBLICATIONS

Owners Manuals	$5 ea
Accessory Catalog	$3
Binocular Buyers Guide Book by Alan Hale	$9.95
Sky Maps	$12
Star Atlas (Northern Hem.) 2000.0	$16.95

MISCELLANEOUS

Lens Caps	$.50 ea
Brass C50 (List $500)	$195
Fluorite SPC80F *Special Unit*	$1399

MISCELLANY LIST

Telrad w/base (Anti-Fog Coated)	$38
Adlerblick 7x50 M/C - 10x50 M/C	$259
Vogel - Digitrak Drives, Inverters	CALL
Questar Tripod, H-D Field Model	$249
Schmidt Camera (with PowerScope)	$1245

10 inch f4.5 complete

DS10A $649

THOUSAND OAKS SOLAR FILTERS — CALL

Glass-Full Aperture 8 in	$79

VIXEN — CELESTRON

4½" ALT. 900mm fl, f/7.9 **$245** (2 Eyepieces)

80MM ALT. 910mm fl, f/11.4 **$375**

90MM ALT. 1000mm fl, f/11.1 **$430** (3 Eyepieces)

4½" EQT. 900mm fl, f/7.9 **$289**

ALL WITH ADJUSTABLE ALUMINUM TRIPOD

BAUSCH & LOMB

(INTERNATIONAL DEALERSHIPS AVAILABLE)

Binoculars • S. Scopes • Wholesale +
BAUSCH & LOMB ACCESSORIES

PROFESSIONAL SERIES PL OCULARS 26mm $45 SYMMETRICAL 7/ 12.7/ 18/ 30mm $33 ea./ 6mm OR $45 ZOOM ORTHO 8.3-21mm $79/ 32mm PL $49/ 50mm HASTINGS $45/ 50mm RAM $29. FILTERS - SERIES 6 DROP-IN SET (6) $49 WITH CASE/ WEDGE + TRIPOD (6000-8000) $249/ EYEPIECE ADAPTER $28/ RFT ASSY $79/ 4x FINDER (4000) $20/ 8x50 FINDER (8000) $45/ MEASURING RETICLE EYEPIECE $45 TRIPOD LEGS (3) $19/ PIGGYBACK MOUNT (4") $21/ (6 and 8") $29/ OTHERS TO B&L ADAPTER $49 LENS CAPS CAMERA ADAPTER .96" $19 F-7.5 FOCAL REDUCER #2 $39/ CAMERA ADAPTER, CFA (PRIME FOCUS) SCH/CASS 4", 6", 8", $49/ OWNERS MANUAL (4000) $5 - (6000-8000) $10 - 4" ELECTRIC DRIVE BASE FORK TINES (4000) $249 SPECIAL TRIPOD $149

WE ARE THE NATIONS "LARGEST BAUSCH & LOMB TELESCOPE DEALER" 2nd to none. ALL ITEMS ARE IN STOCK FOR FASTEST DELIVERY POSSIBLE!

HARBOURMASTER (BRASS) 18th CENTURY COPY $1649
(AS ADVERTISED IN "NATIONAL GEOGRAPHIC MAGAZINE")
SUGGESTED LIST $4,000

Meade

TELESCOPES

97 D, 97 E, 97 ERII, 97 EII, Spotting Scope	from $299
2045 Spotting Scope	$432
2081 Spotting Scope 8" f10 $719 f6.3	$749
312: 3.1" (80mm) f/11 Alt. Refracting Telescope	$323
323: with Equatorial Mount	$434
2.4" (60mm) Alt. Refracting Telescope	$89
2.4" (60m) Equatorial Refracting Telescope	$149
#228 2.4" BRASS $288 #314 3.1" BRASS	$624
4420 4½" Reflecting Telescope	$299
SN8-8" SCH/NEWT. f4 O.T.	$595
826C 8" f/6 Newt. w/Motor Dr. & equatorial mount	$799
1060: 10" f/6 Refl. Telescope Research Series	$1800
1266: 12" f/6 Refl. Telescope Research Series	$2500
DS-10A: 10" f/4.5 Reflecting Telescope	$649
DS-16AB: 16" f/4.5 Reflecting Telescope	$1749
2060 16" f10 SCH/CASS	$9999

BINOCULARS

11x80 M/C, 20x80 M/C Armored	$299
7x42, 10x42 $185 8x32	$175

ACCESSORIES

Equatorial Wedge plus Tripod 2045	$229
Super Wedge 10"	$299
Equatorial Wedge for Model #2080, #2045	$78
Equatorial Wedge for Model #2120	$98
Field Tripod for Model 2080, 2120	$205
Field Tripod 2080 Basic	$159
Photo Tripod "Superstar"	$95
Altazimuth Adapter for Field Tripod (2080 2120)	$18
Fork Mount/Drive 4" $274 "8" $624 10"	$724
Deluxe Latitude Adjuster: 2080, 2120	$25
Setting Circle Illuminator System: 2080, 2120	$36
L.E.D. Map Light: 2045, LX3, 2080 LX3, 2120 LX3	$26
#605 Magnetic Compass	$10
#607 25' Extension Cord for use with AC Converter	$16
Azimuth Control (for Field Tripods for Model 2080)	$15
#603 DC Cord (25') w/cigarette plug	$16
#604 AC Converter w/25' Cord	$26
#1200, 1200A Electric Focuser"	$193
#671 Wide-Field Adapter System (WFAS complete)	$98
Tele-Compresser Lens only	$39
Tele-Compresser System comp. w/Extender Tube	$54
Eyepiece Extender Tube only	$18
Off-Axis Guider Body only	$65
Off-Axis Guider Assembly comp. w/illuminated	$129
#419/#427 Illum. Ret. Eyepiece Sys. .965", 1.25"	$78
#702A Double Crossline Reticle	$24
#705A Micrometer Reticle	$26
Spotting Scope adapter Plate: 2080, 2080 LX3, 5 & 6	$40
H35mm Crosshair Eyepiece (.965) R9MM	Each $36
Spotting Scope Adapter Plate: 2120, 2120 LX3, 5 & 6	$52
Mod. Ach. (.965) 9, 12, 25, 40mm	$34
40mm Mod. Achromatic ep., 1.25"	$39
.965 Orthos: 4mm, 6mm, 9mm, 18mm Oculars	$39
1.25" Orthos: 4mm, 6mm, 9mm, 12.5mm & 18mm	$46
Sup. Plossl 1.25"	
6.4mm, 9.7mm, 12.4mm, 15mm, 20mm & 26mm	$63
32mm, 40mm, 1.25"	$82
56mm, 2"	$156
13.8mm Super Wides 1.25"	$104
18mm 1.25"	$112
24.5mm 1.25"	$117
32mm 2"	$177
40mm 2"	$249
4.7mm 1.25"	$117
6.7mm 1.25"	$142
8.8mm 1.25"/2"	$170
14mm 1.25"/2"	$198
Rotary Multiple Holder 1¼	$124
Eyepiece Holder, 1.25"	$26
#915 Diagonal Prism .965	$36
#917 Hybrid Diagonal Prism (.965/1.25)	$36
#918 Diagonal Prism 1.25"	$36
#919 Diagonal Prism w/threaded Ring 1.25"	$40
#929 2" Diagonal Mirror including	
eyepiece adapter w/1¼" Adapter	$135
#930 2" Diag. Mirror, 2" OD Barrel for	
2" Focuser Sleeve	$129
#926 Image Erecting Lens (220, 226)	$19.50
#924 Erecting Prism 1.25"	$56
#928 Erecting Prism System 45°	$46
#912 Roof Prism .965 90B, 97D, 97E, 97ER	$66
#931 Hybrid 45° Erecting Roof Prism	$49
Photo Visual Color Filters & Polarizer	
.965", 1.25" All Col. Avail.	$11.50
Set of 6 Photo Visual Color Filters	$68
Set of 6 Photo Visual Filters (.965) Thread In	$68
Series VI Drop-In Filter Set 102, 107D	$49
Series V Drop-In Filter Set 90B, 97D, 97E, 97ER	$46
#905 Variable Polarizing Eyepiece System 1.25"	$48
#910 Nebula Filter 2"	$102
Electronic Control Center	$229
Nebula Filter #908 1.25	$65
#911 Nebula Filter (rear cell Thread on)	$98
#122 2X Tele-negative Amplifier (for all 8" & 10") 1¼"	$40
#126 (2045), 1¼" Barlow	$39
#127 2X-3X Variable Tele-negative Amplifier	$54
#131 2X Tele-negative Amplifier .965 (291, 294)	$36
#140 2X Tele-neg. Amplifier (for all 8" & 10") S/C	$61
#581 Sun Shade ST Model SS	$46
#582 Dew Shade for 107D, 2045	$46
C.A.T. for 8/10" $829 Digital Readout 8/10"	$288
#710 Dew Shield 10" 2120	$104
#712 Dew Shield 8" 2080	$89
#1A Skylight Filter/Dust Seal	$44
#50 Accessory Case	$59
Extra 2lb Weights for 1401 or 1402 each	$20
Tube Balance 2045	$43
#1401 Tube Balance Weight System 2080	$74
#1402 Tube Balance Weight System 2120	$78
Extra Counterweight 25lb: 880, 1060, 1266	$66
Extra Counterweight 40lb: 880, 1060, 1266	$86
#67 Focuser 1.25" I.D.	$44
#640 Focuser 1.25" I.D.	$68
#680 Deluxe Focuser 1.25" & 2" I.D.	$88
#59 Adapter Photo Pathfinder only	$18
#60, #61, #62, T-Adapters	$22
#64 T-Adapter only, for WFAS	$34
Tele-Extender	$22
Basic Camera Adapter 1.25", .965"	$34
Variable Projection Camera Adapter 1.25"	$45
2" Prime Focus Adapter	$39
Prime Focus Camera Adapter (277)	$20
T-Mount Camera Ring Adapters	
(Spec. Camera & Model)	$10
Extension Tube Set (15mm, 30mm, 45mm)	$39
#708 Piggyback Camera Adapter (310, 320)	$36
Piggyback Bracket: 2080/2120	$30
Piggyback Bracket: 2045	$16
#631 6x30mm View Finder w/bracket	$42
#967 9x60 Polar Illuminated View Finder w/bracket	$142
Bracket for #541 View Finder	$12
#634, 6x30 View Finder w/bracket — MTS 6-8	$42
#541 5x24 R/A View Finder	$45
#544 8x50 View Finder w/bracket — SC8	$76
Mounting Brackets (2.38") or (3.6" I.D.)	$28
#781 Electric Motor Drive, AC (323, 4420)	$79
#787 Electric Motor Drive System (DS-10)	$96
#897 Electric Motor Drive System (DS-16)	$187
#55 Manual Declination Control 628C, 645C, 826C	$69
#65RS Manual Declination Cont. 880, 1060, 1266	$106
#48RS Dual Axis Dr. Corrector Sys. 880, 1060	$369
#36 Single Axis-Dual Axis Drive Corrector Control	$81
Electronic Control Center	$229
#43 R.A. Drive Corrector operates from 12VDC	$81
#46 Dual Axis Drive	$259
#47M Dual Axis Dr. Corrector Sys. 628C, 645C	$294
#38 Declination Motor Ass. 2080LX3, 2120LX3	$82
#38B Declination Motor Assembly 2080, 2120	$84
#38M Electric Declination System	$74
#39 Declination Motor for LX5, LX6, Premier	$84
#66A Manual Declination Control	$42
#66C Manual Declination Control	$54
#56 Declination Control	$99
Casters (2" Diameter) for DS-16 (set of 3)	$38
Leveling Screws for DS-16 (set of 3)	$38
Leveling Screws for DS-10 (set of 3)	$29
#868 Extension Tube (2") (DS-10A, DS-16A)	$20
Setting Circles for DS-10: 3" Diameter w/pointer	$30
Setting Circles for DS-16: 6" Diameter w/pointer	$56
Vinyl Dust Cover for DS-16	$26
Vinyl Dust Cover for DS-10	$19
Lens Caps — 96, 1¼	$.50 EA (7 for $3)
Vinyl Dust Cover pair 6" (628C, 645C)	$26
Vinyl Dust Cover pair 8" (826C, 880), 10" (1060)	$36
Accessory Shelf for DS-10	$39
Accessory Shelf for 880, 1060, 1266, DS16	$49
Accessory Shelf for Field Tripod (2045, 2080, 2120)	$24
#AD-1 Eyepiece Adapter .965, #AD-2 1¼"	$18
Mirrors, Eq. Mounts - Please call for quotes	

IN STOCK **TELESCOPES**

2045D...$599 Carry Case...$66

"Smart Drive" "PPEC" Units

	30 40	46	50	56	70	76
2080	**$1399**					
2120	**$1599**					

CLOSE OUTS

NEW MEADE PRODUCT LINE - CALL!

DISTRIBUTORS/ JOBBERS / RETAIL / WHOLESALE - IMPORT - EXPORT

PUBLIC WELCOME

KNOWLEDGEABLE STAFF ON ORDER LINES (7 DAYS) 10 AM to 10 PM

Showrooms – 57 North/Suite 401
BUSINESS OFFICES – SAT. 11 TO 5 PM (TAG SALE SPECIALS)

OFFICE/SHOWROOM
TEL: (203) 792-0218
— Trade-ins considered —

WHOLESALE OPTICS

MAIL ORDERS TO:
29 Kingswood Road
Danbury, CT 06811
TEL: (203) 746-3579
FAX (203) 746-7572 (24 HRS.)
FAX ORDER LINE ONLY

— NO SALES TAX —

Buyers Guide

Telescope-Accessory Catalog (2 lbs.) $5
Telescope-Accessory Catalog/Data Pack (3lbs) $10.00 Refundable
Complete pkg.-Telescopes, Spotting Scopes, Accessories, Binoculars **(4lbs.) $15**
Minimum Shipping Charge (via UPS) $5.00
Phone Orders 10 a.m.-10 p.m. (7) days a week
(CT. Tax for in-state sales only)

3% credit charge

PUBLIC WELCOME

FUJINON

7x50 MT-SX $300
7x50 MTR-SX $325
7x50 MTRC-SX $375
10x70 MT-SX $395
7x50 FMT-SX $365
7x50 FMTR-SX $390
STAR SCOPE $1849
7x50 FMTRC-SX $440
10x70 FMT-SX $439
16x70 FMTSX $559
25x150 MT $6099
TRIPOD BKT 14

LOWEST GUARANTEED LISTED PRICES!

KOWA SPOTTING SCOPES
TSN-1 $309
TSN-2 $299
TSN-3 $689
TSN-4 $649
TS601 $249
TS602 $239

3 PART SERIES

PART I

Building Owl Observatory

Tired of lugging your telescope around and observing in the cold? Build a well-designed observatory and explore the sky in comfort.

Story and photos by Jim Krick

Not long after the purchase of my telescope, I thought about how great it would be to have my own observatory. During the next six years, I made a list of the problems I encountered when observing in order to determine what would be best for my observatory design. Several years of cold feet, numbing winter wind, dropped set screws, kicked tripods, broken cables, and dead car batteries taught me what I really wanted.

To get a better idea about how to solve my problems, I looked through ASTRONOMY magazine and read *How to Build Your Own Observatory* (which contains reprints from *Telescope Making* magazine). I wanted an efficient, easily manageable, and comfortable structure that would fulfill all of my needs. No single observatory described in these magazine articles seemed just right for me, but I did pick up some ideas. Still, I had to choose between a roll-off roof and a dome and between a concrete and a wooden floor. And where to build my observatory — in my backyard or out of town, away from the lights? What about my abilities as a builder? I am not a professional carpenter, just an average do-it-yourselfer. My observatory would have to be built with powered hand tools, including a saw, a small miter saw, a scroll saw, a couple of drills, and a borrowed router.

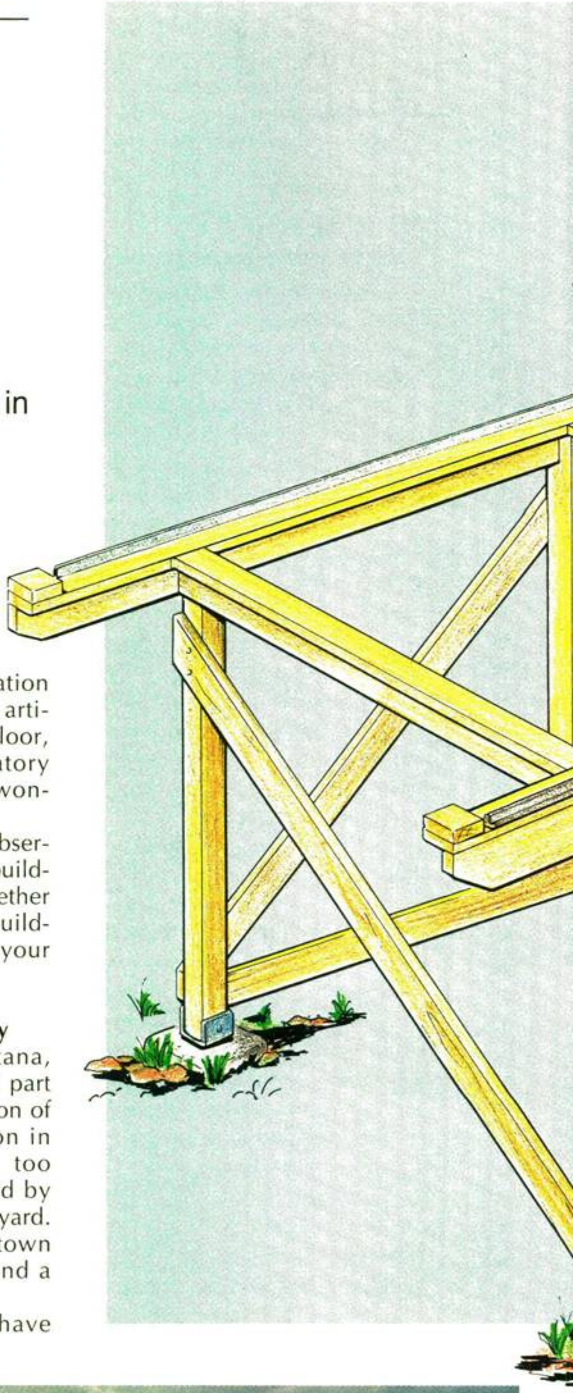
This article will show you how I solved these problems and built the foundation for my observatory. Two later articles describe how I built the floor, walls, and roof. The observatory cost only $1,500 and was a wonderful project.

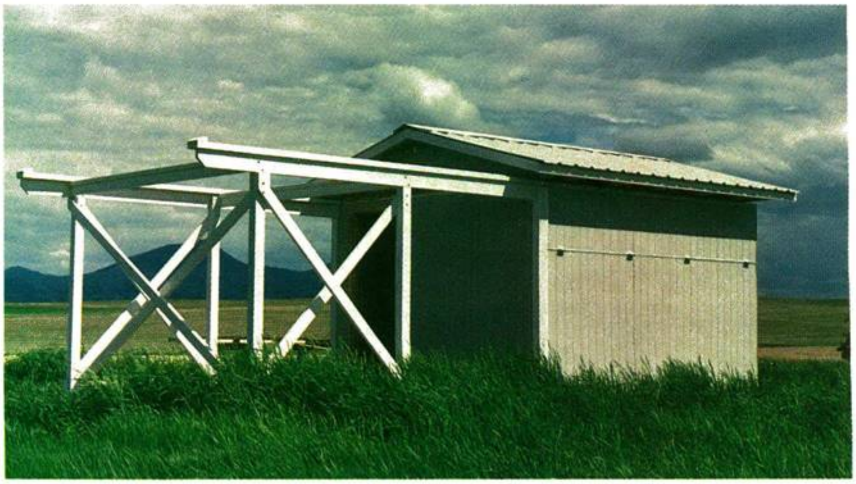
(Note: Before you build a observatory, check with your local building inspector to determine whether you need a permit and what building restrictions may apply to your structure.)

Designing Owl Observatory

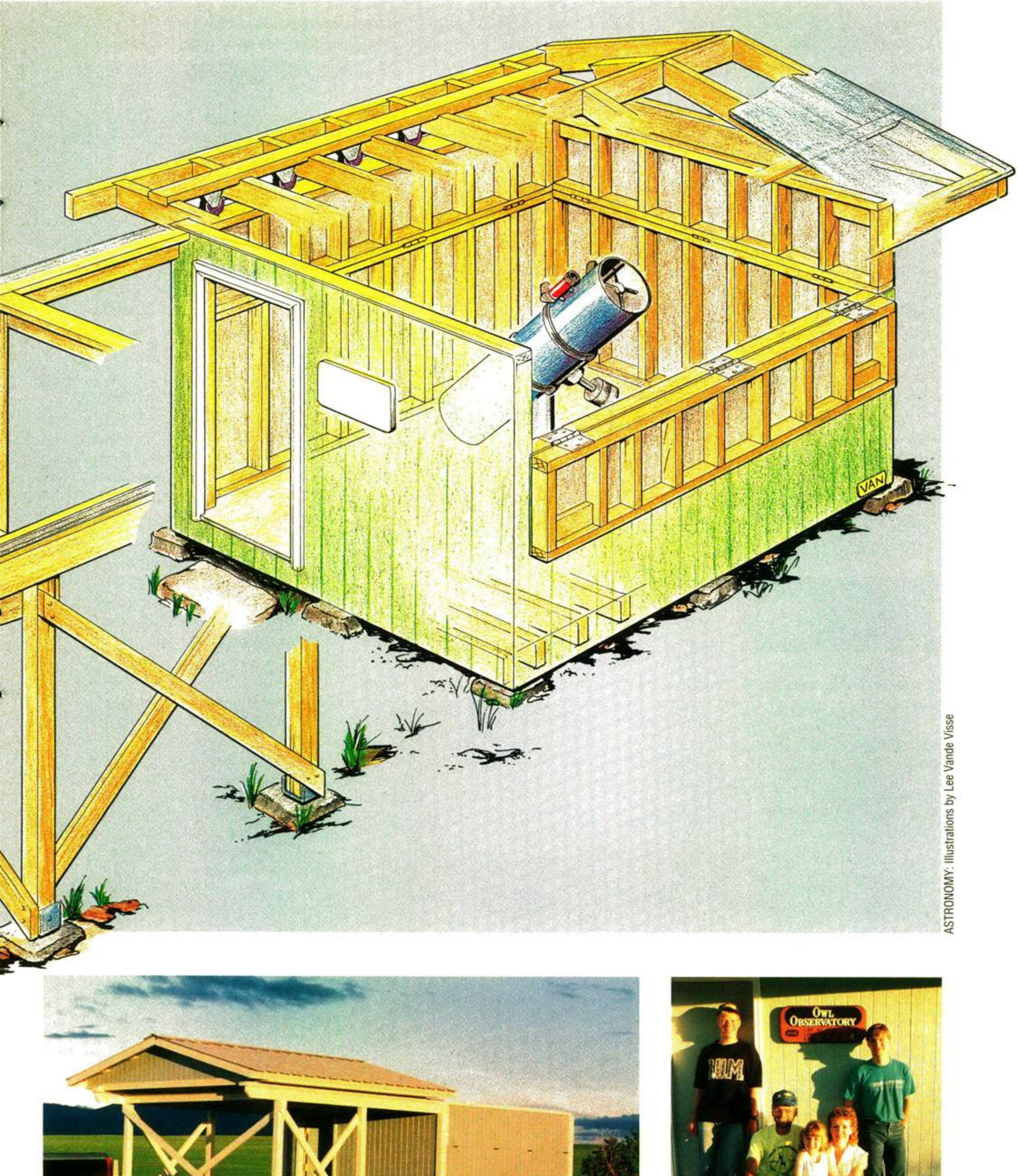
I live in Great Falls, Montana, which is located in the central part of the state and has a population of about 50,000. Light pollution in town is unacceptable, and too much of the sky is obstructed by trees and buildings in my backyard. So I decided to build out of town where there are dark skies and a clear horizon.

For the past few years I have



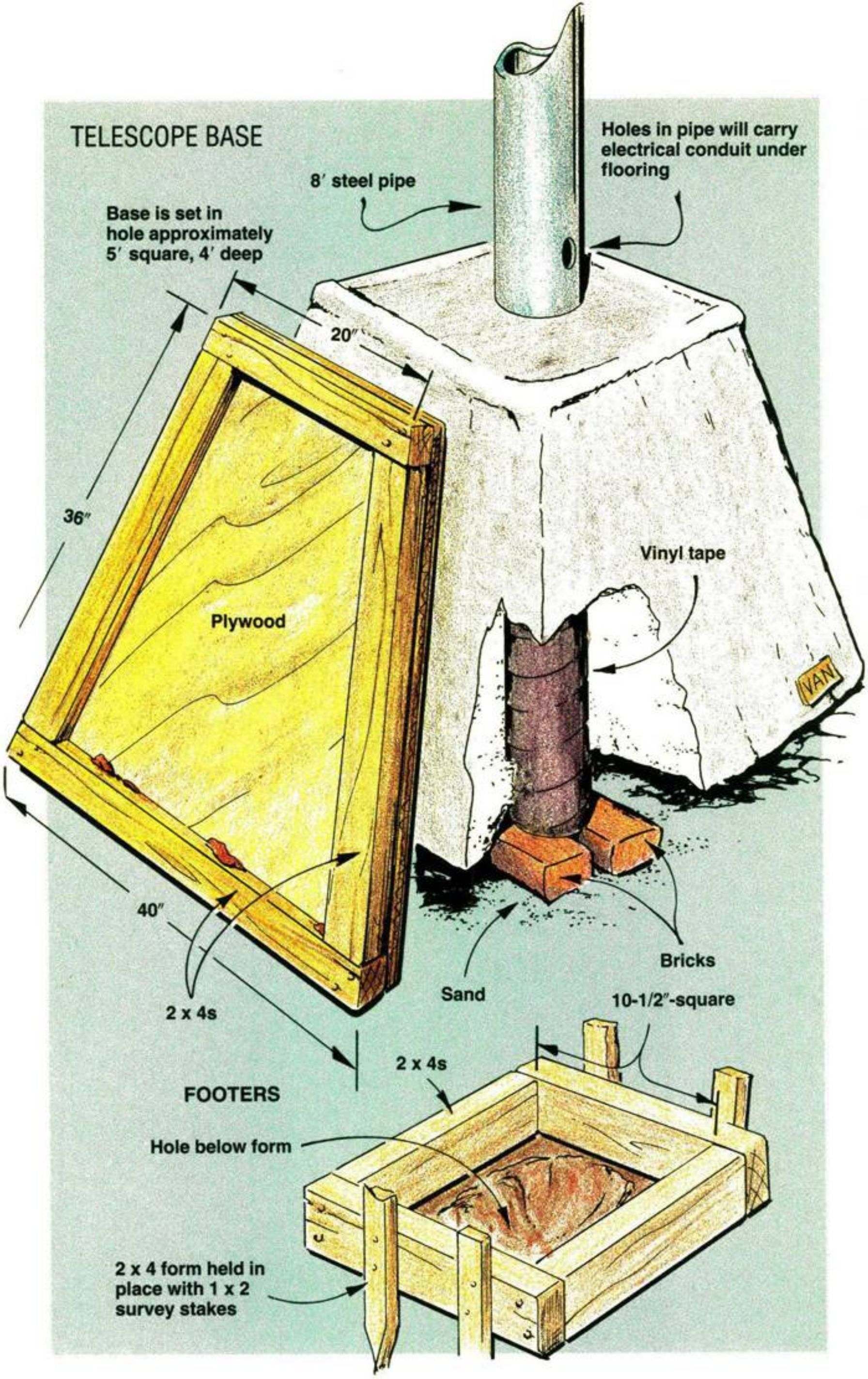


THE ROOF ROLLS OFF to the north and the walls fold down to permit access to the night sky (center right), yet they close tightly to seal out the elements (right). The observatory is a great place for family outings (far right).



ASTRONOMY: Illustrations by Lee Vande Visse

OWL
OBSERVATORY


TELESCOPE BASE
8′ steel pipe
Holes in pipe will carry electrical conduit under flooring
Base is set in hole approximately 5′ square, 4′ deep
20″
36″
Plywood
Vinyl tape
VAN
40″
2 x 4s
Sand
Bricks
10-1/2″-square
2 x 4s
FOOTERS
Hole below form
2 x 4 form held in place with 1 x 2 survey stakes

THE STEEL TELESCOPE PIER is set in a pyramid-shaped mass of concrete. The pipe sticks out of the bottom of the concrete to prevent condensation.

packed my scope in my truck and driven to an abandoned farm about 25 miles east of Great Falls near the small community of Highwood. This old homestead has a weathered windmill and a small reservoir and is surrounded by fields of wheat and barley. This site is not only ideal for observing and astrophotography, but abundant wildlife and the nearby scenic Highwood Mountains make my outings an enjoyable and relaxing experience.

The property is owned by Earl Davison, who is a farmer, rancher, and friend. Earl agreed to meet me at the site and discuss my plans for an observatory. A few hours later my dream began to become a reality when Earl agreed to lease some land and I could start to build my observatory.

Although I am not an architect by any stretch of the imagination, I think my plan is a good one. As an astrophotographer, I want clear access to the entire sky. I felt the view of the sky through a dome was too restrictive. So I chose to build a roll-off roof, which would also save on cost. For greater access to the horizon, the top two feet of the east, south, and west walls fold down. The entrance is in the north wall and the roof rolls off to the north, so there is no point in having this wall fold down. The telescope is mounted on a steel pipe set in concrete. And the wood floor is raised, which helps to keep my feet warm in the winter.

The building is 10' square, providing ample room for the telescope, with room left over for a table to hold charts and extra equipment. The rails for the roll-off roof make the overall structure 10 x 20 feet.

The work progressed in three phases. Phase one was the construction of the pier and building foundations. This was done during the summer and fall of 1990. Phase two included building the floor and walls. This work was started during the winter in my garage and finished at the site in the spring and summer of 1991. The final stage was building the roof. This enclosed the observatory before the winter of 1991 struck.

PHASE ONE

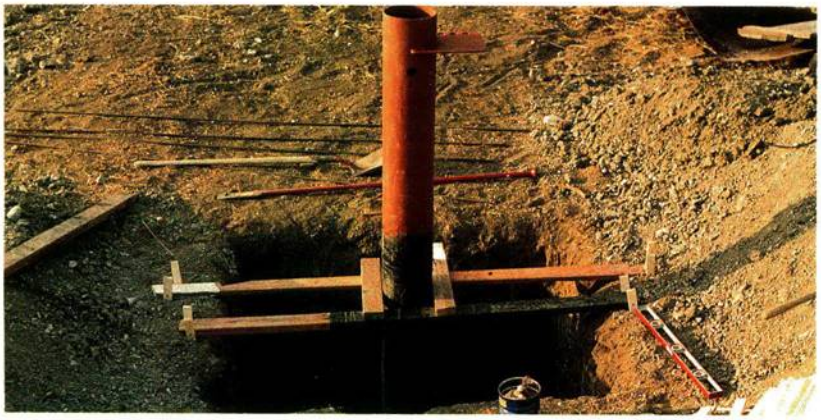
The Pier

It is easier to cast the pier first and then cast the building footings. This order of events ensures that the building will be centered on the pier. My pier consists of an 8" steel pipe set in a pyramid-shaped concrete footing. The pyramid shape gives the footing a low center of gravity, which should help prevent shifting in the ground.

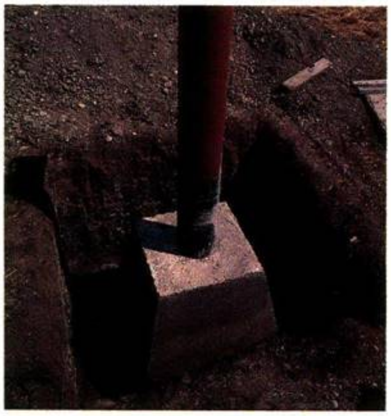
In any case, a pier means digging a hole in the ground. Dig a hole much larger than you need for the footing so you'll have room to install and remove the forms used for pouring the concrete. My footing measures 40" square at the bottom, 20" square at the top, and 3' high. My son Josh and I dug a hole 5' square and 4' deep. It took us over four hours to dig the hole by hand.

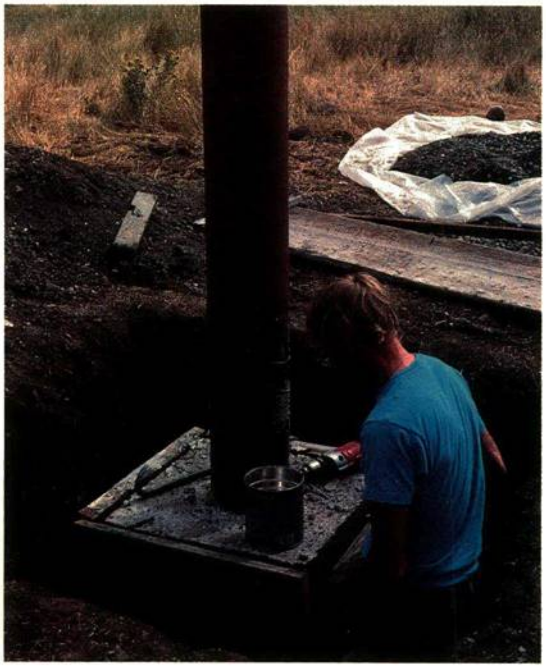
For the sides of the form, I cut four trapezoid-shaped pieces from 1/2-inch exterior grade (CDX) plywood (see the illustration above). I then reinforced the plywood with 2x4s along the top, bottom, and each side. Everything was fastened with screws. Building forms to hold about a yard of concrete is one place where you want to make everything as strong as possible.

New pipe is expensive, but you can go to a junk yard or scrap metal dealer and buy used pipe. I was lucky to be given an 8' length of used pipe. I bought a scrap piece of quarter-inch plate steel and welded it to the pipe for use as an accessory



THE HOLE FOR THE PIER is dug to a depth of four feet. Then the pipe wrapped in vinyl tape is set plumb and held in place with stakes and 2x4s (above). The eyepiece shelf and hole for the electrical conduit are visible at the top of the pipe.





AFTER THE CONCRETE SETS, the forms may be removed (above) and the hole backfilled with dirt (left). Replace only about six inches of dirt at a time and tamp it firmly to prevent the pier from settling later.

shelf. Several 1 1/4-inch holes drilled in the plate will hold eyepieces during my observing sessions. Not everyone has welding equipment or the tools necessary to drill holes in plate steel, but you can go to a local machine shop to have this work done for you.

Toward the top of the pier, I drilled a hole for conduit to run into an attached electrical outlet box and a second hole where the conduit exits the pier under the floor. At that time, I didn't know when I would get electrical power installed at the observatory site, but holes couldn't be drilled in the pier once it was installed. In the meantime, I could use the conduit with a DC battery and never again worry about tripping over power cords.

Before setting the pipe into the ground, I coated the lower four feet of the pipe — the part to be underground — with a quick-drying tar and then wrapped it with vinyl tape. (This technique is used in gas construction to prevent corrosion of steel gas lines.)

Now to set my pier and forms. The pier should extend through the bottom of the footing to allow any condensation that forms to drain away and, thus, prevent rust and corrosion. I did this by digging a 6" deep, 18" square hole in the bottom of the pier hole. I put two bricks in the center of this small hole and placed my pier on top of them. The pier was supported across the top of the big hole by 2x4s, which in turn were screwed to stakes that were driven in the ground (photo above). I could plumb the pier easily by moving the end that was resting on the bricks. Once the pier was plumb, the small hole was filled with gravel. The gravel helps to keep the pier in place while pouring the concrete and insures that the pier will extend out the bottom of the footing afterward.

The forms were installed one at a time around the pier and screwed together. After centering the forms around the pier and leveling them, I drove stakes into the ground around the bottom of the forms and screwed them to the forms. Use at least three stakes on each side, because concrete has a tendency to lift the forms and push out through the bottom.

When pouring concrete, don't forget to put in reinforcing bar. Also called rebar, it strengthens the footing and holds it together if it develops cracks. Since it's nearly impossible to pour such a large volume of concrete and not have some cracking, it's a good idea to install rebar.

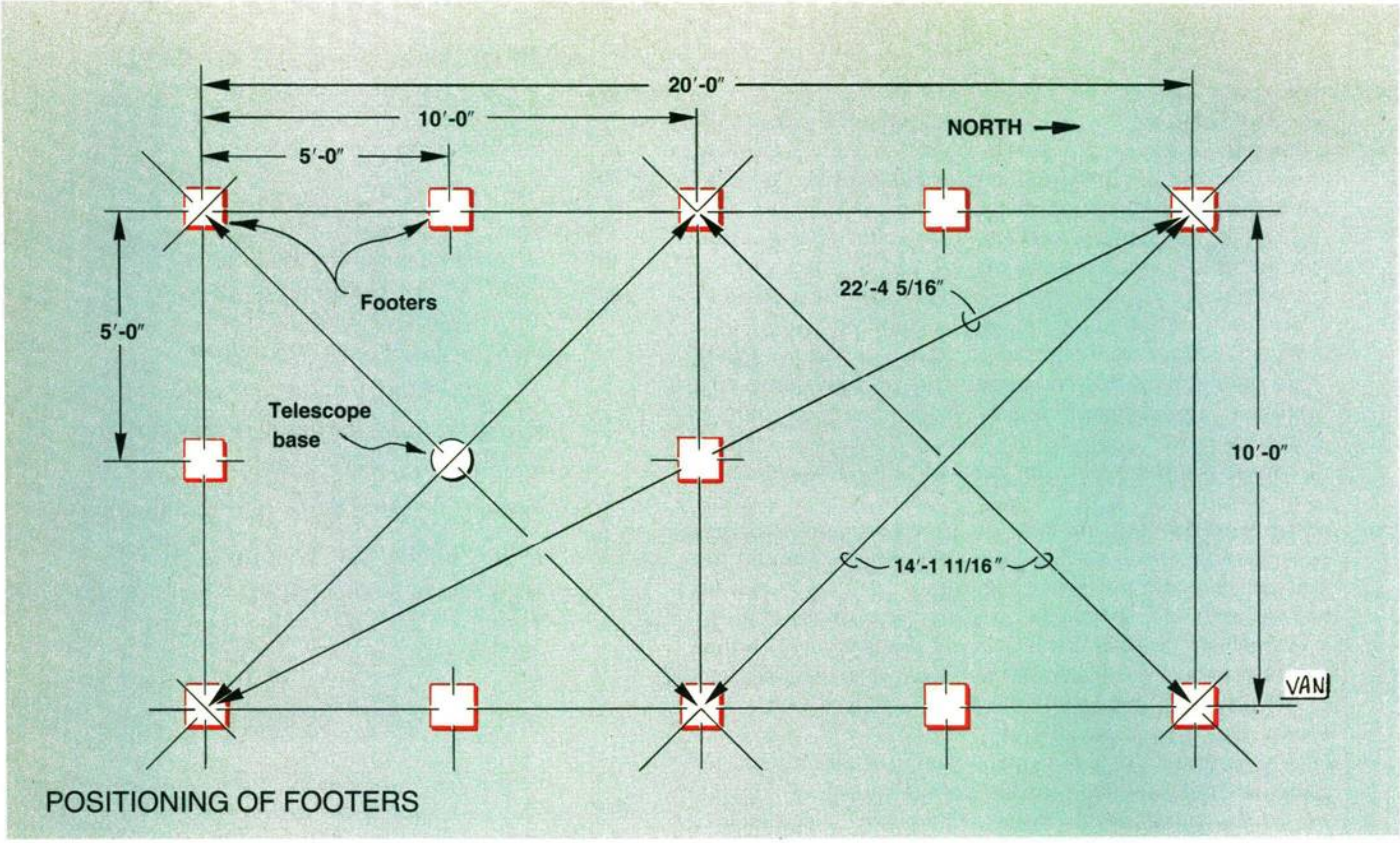
I needed a little under one yard of concrete to pour the footing for my pier. Locally, delivered concrete costs $65 a yard. But there was one string attached. Since the job site was outside the city limits, a $95 delivery charge would be added to the cost of the concrete. I decided instead to mix and pour my own concrete. (In some areas, you can borrow or rent a small trailer to haul ready-mix concrete instead of having it delivered by truck.)

One evening I hauled about a cubic yard of mixed sand and gravel in a rented trailer. The following evening Josh and I took a rented gas-powered cement mixer, five bags of cement, and thirty gallons of water out to the site. We mixed the concrete following a one part cement to three parts sand and gravel recipe. The normal mixture is one to five, but I wanted a stronger-than-normal pier footing. About a week later I removed the forms. The cost of the materials and rentals came to $90. And I had enough material to complete the footings for the building.

I filled in the remainder of the hole with the dirt from the excavation, shoveling in only about six inches at a time. To eliminate later settling of the pier, I thoroughly tamped each layer. I raked the leftover dirt level to prepare for construction of the building footings.

The Foundation

While designing my observatory, a major concern was the longevity of the structure. I wanted one that would last my lifetime. I did not



POSITIONING OF FOOTERS

TWELVE FOOTINGS FORM THE FOUNDATION. Using the dimensions from the plan at top, stakes were first driven at the corners of the structure (above). To locate the holes for the footings, batterboards and strings were placed outside the stakes.

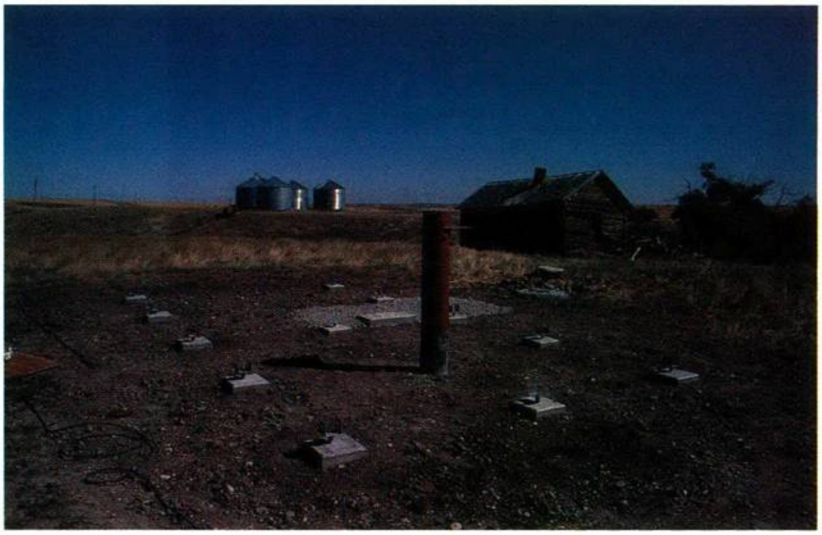
want the structure lying on the ground because the wood had rotted. So my observatory has a raised floor. Also, mice are plentiful in this neck of the woods. I don't want to walk into my observatory some night and have it smell like a barn or a grainbin. Few mice will nest under the raised floor. Any that do probably will be cleaned out by varmints — I hope I don't show up some night with a skunk under my feet!

To support the raised wooden floor and the posts for the roll-off roof rails, I set metal post brackets into concrete footings. Eight footings were needed for my 10-foot square building and four more for the rail posts (see the illustration above). I considered using preformed concrete footings available from hardware stores, but they are expensive. Besides I already had all of the supplies necessary for casting my own, left over from making the pier.

Laying out the foundation is one of the most important parts of this whole project. If the foundation is not level and square, you're in for a big headache because it will be hard to build the walls, and the roll-off roof may not work properly. Take your time to get your foundation laid out right.

Laying out a foundation requires only a compass, strings, levels, two tape measures, wooden stakes, and a little high school math. (You can use a transit if you know how to use one or have a friend who does.) First, I ran a 15' string along the east-west direction tangent to the south side of the pier's steel pipe. Five feet on each side from where this string touches the pier, I ran 25' strings in the north-south direction. The strings should extend roughly 7' south of the east-west string. Stakes made from 2x4s driven into the ground near the ends of the strings held them taut. (A nail pounded into the top of the stake will make it easier to adjust the strings.) Next, I marked the corners of the foundation.

I started by laying out the northwest and southwest corners, driving a stake to mark the location of each corner. The southwest corner is 5' south of the east-west string and the northwest corner is 15' north of the string. (To center the pier exactly in your building, subtract the radius of your pipe from the southwest corner distance and add it to the northwest corner distance.) I double-checked that the stakes were exactly 20'



AT THE END OF THE FIRST PHASE OF CONSTRUCTION, the concrete footings and pier have been cast and the observatory site has been raked level in preparation for the construction of the floor and walls.

from nail to nail and then removed all the strings used to this point to reduce later confusion.

Next, the northeast stake. It has to be perpendicular to the west side of the building defined by the two newly installed corner stakes. You could use a compass to lay out this stake, but that isn't very accurate. Instead I used the diagonal measurement of the building. The diagonal may be found from the Pythagorean theorem — the square of the diagonal is equal to the sum of the squares of the north and west sides. For my building the diagonal is 22'-4$^{5}/_{16}$" (the square root of 500, or 20x20 + 10x10).

From the northwest stake, I measured 10' to the east. Using a second tape, I simultaneously measured from the southwest stake 22'-4$^{5}/_{16}$" to the northeast. I drove a stake — and nail — to mark where these two measurements intersected. The southeast corner was marked in the same way, 10' to the east of the southwest stake and 22'-4$^{5}/_{16}$" to the southeast from the northwest stake. Double-check these two diagonal measurements to be sure that the foundation will be square.

Once the four stakes were set and square, I placed the batterboards that will actually hold the strings used to lay out the footings. The corner stakes must be removed to excavate the holes for the footings. Yet once the holes are dug, we still need the strings to help us set the post brackets accurately in the footings. Place batterboards outside the planned foundation; they are ideal for holding the strings.

To make a batterboard, screw a short piece of wood to the top of two stakes. You'll need to make eight of these, two for each corner. I drove one batterboard into the ground about two feet from the corner stake on each of the outside directions. For example, for the southwest stake, I placed one batterboard two feet south of the corner stake and a second batterboard two feet to the west of the stake (see photo on the opposite page). Once you've driven all of the batterboards into the ground, run four strings (one for each side) so they just touch the nails on the corner stakes. Pound nails into the wood strip of the batterboard to hold the string in place.

You'll need two more sets of batterboards. One divides the foundation into two 10 by 10 foot squares. Place this set of batterboards so their centers are about 10' from the northern string. The position of the dividing line is best measured using diagonals. The southern square has the pier obstructing its center so it is easier to measure from the northern corners. I measured 14'-1$^{11}/_{16}$" from these corners to the side strings and marked these intersections with a string running between the batterboards.

Place the last set of batterboards with their centers about 5' from the northern string. These boards mark the location of the second pair of posts for the roll-off roof rails. I used diagonals from the northern corners of length 11'-2$^{3}/_{16}$" to mark the position of this string.

As the final step of the layout, I marked the midpoints in each side of the southern square. Since the square is 10' on a side, I tied a short piece of string onto each string 5' from each corner. The intersections of the strings and knots in the southern square should mark the positions for 12 footings. Finally, I double-checked all the string measurements and leveled the strings.

For each footing, I dug a hole 10$^{1}/_{2}$" square and 10" deep. The hole was centered at each point marked by the strings. After digging the hole, I tamped the bottom so the footing won't settle later. The top of the form was made from 2x4s. I drove stakes into the ground around the form and screwed them to the 2x4s.

I placed in each hole stirrup-shaped post supports available from the hardware store. The supports have 12" sections of $^{3}/_{4}$-inch pipe welded to the bottom. This wasn't long enough so I inserted some $^{1}/_{2}$" pipe to get a total length of 18". The extra length of pipe enabled me to drive the pipe into the ground to hold it in place in the center of the form. Each post support was first centered under its string marker and leveled. Then I drove the supports into the ground until they were a uniform distance below the string. The distance from the string will depend on the height of your batterboards, but I set the bottom of my post brackets 4" above the ground.

When all the forms and post brackets were in place, I rechecked the brackets to see that they were level and at the same height. I mixed the concrete by hand in a wheelbarrow and poured the pads. Between wheelbarrow loads, I edged and finished previously poured footings. It took a good day's work to lay out the foundation, dig the holes, and pour the concrete. A few days later I removed the forms, cleaned up the area, and raked and leveled the dirt left over from the excavations.

At this point, phase one was finished. With winter coming on, work stopped at the observatory site. During the long winter months, I prefabricated the observatory walls in my garage. In our next installment, I'll tell you how I built the floor and walls. □

Part two of Jim Krick's "Building Owl Observatory" will appear in the May issue and part three in the June issue.

EXPLORE the Lunar Rays

Next Full Moon, don't let your telescope sit idle. Haul it out and explore the bright streaky rays crisscrossing the face of the Moon.

by Edmund Fortier

It's a pity that lunar observers shun the Full Moon. As flat lighting and bright glare erase the shadows, backyard astronomers aim their telescopes elsewhere or put them away. But if you keep your scope capped at Full Moon, you're passing up one of the greatest spectacles that our sister world has to offer: the bright spatter-patterns of the lunar rays.

New Features on an Old, Old Landscape

Craters with rays are among the Moon's most varied and attractive features, even in a small telescope. Rays reach their greatest brilliance at Full Moon, when they dominate the lunar disk. The craters they come from range in age from a few million years to over 800 million, which is young in lunar terms. Although ray craters are scattered randomly across the lunar landscape, those on the surfaces of the maria — the dark plains of frozen lava — tend to show rays most dramatically.

The nature of lunar rays long remained one of the solar system's most tantalizing mysteries. Some early astronomers thought rays might be salt deposits left behind when the supposed "seas" dried up. Other observers theorized that rays were stains caused by hot vapor vented along geologic faults. Still others speculated that stresses within the Moon created radial patterns of fissures that were later filled with bright molten material. Early 20th-century astronomers, believing lunar craters volcanic, concluded that rays were dust deposits ejected from long-dormant volcanoes.

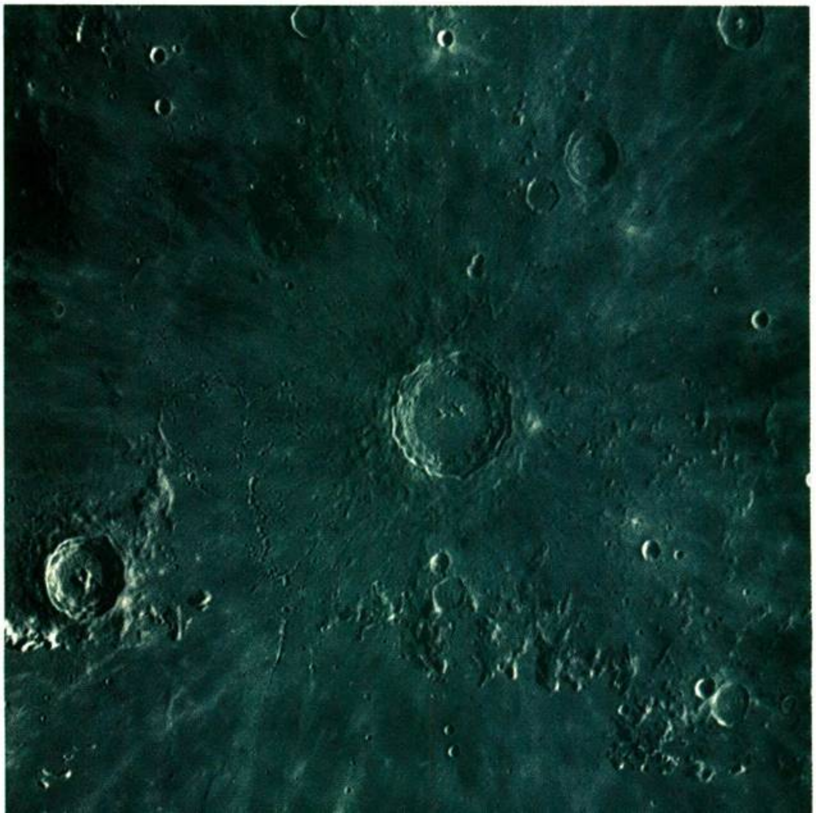
Today we know that lunar craters result from meteor impacts and that most impacts produce rays. When a chunk of cosmic debris strikes the Moon, the explosion almost always sprays material in a radial pattern. The biggest pieces of debris form a continuous apron of ejecta close to the crater. Farther out, less coarse material produces a patchy ejecta blanket along with clusters of secondary craters. The finest-grained ejecta travel farthest from the point of impact and separate into thin filaments which then settle onto the surface as streaks and rays.

Readying Your Telescope

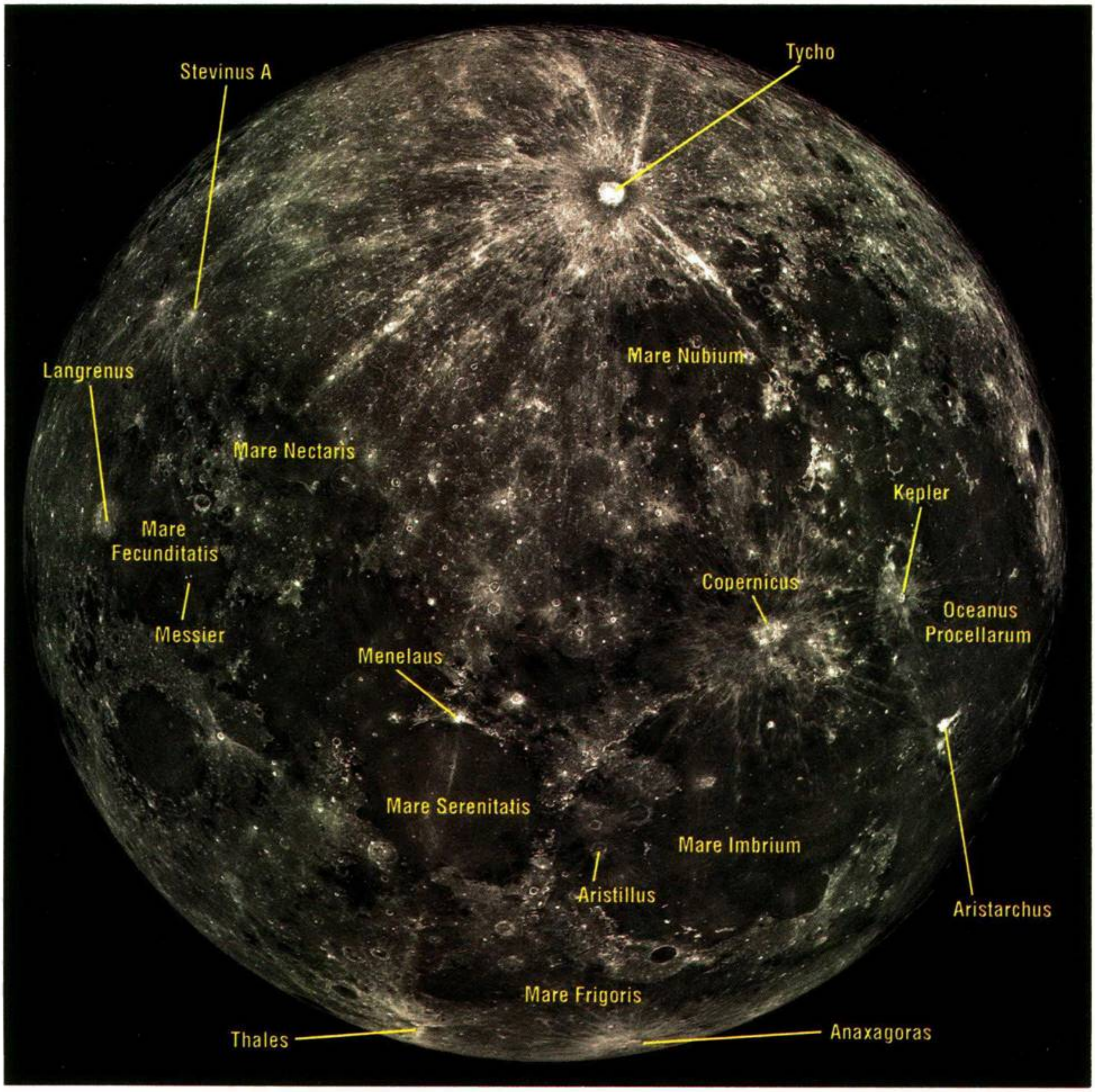
Lunar rays reflect sunlight most strongly straight back toward the Sun, so observing them at their best means viewing at Full Moon, a dazzling sight. You can cope with the glare in several ways. With a small telescope, your eye will probably adjust to the brightness easily enough. With medium and large scopes, however, consider reducing the aperture by means of a mask with a circular hole in it. (If you have a reflector, place the hole off-center so that it falls between the edge of the tube and the secondary mirror and its support vanes.)

Some observers don't like to reduce their instrument's aperture, so they equip their eyepieces with neutral-gray Moon filters — lunar sunglasses. A neutral density filter, either by itself or combined with a deep red filter, will reduce glare and enhance contrast.

While viewing craters often calls for high magnifications, many



SPLASHED BY THE IMPACT, the rays of Copernicus trace an intricate pattern across the lava plains of Oceanus Procellarum. Lick Observatory photo.



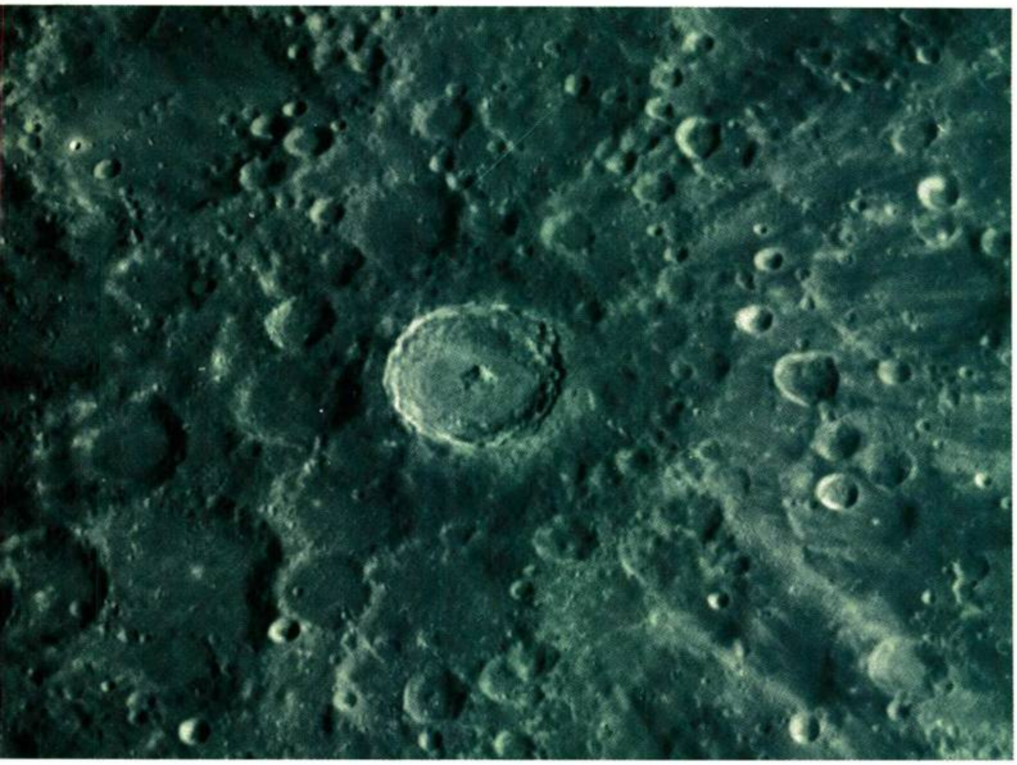
FULL MOON IS THE BEST TIME for exploring the ray systems that surround the Moon's youngest craters. (South is at top in these photos to match the telescopic view.) Lick Observatory photo.

ray systems run for hundreds of miles. Often observers find a low-power eyepiece — one that allows you to see the entire lunar disk along with a portion of sky — provides the most pleasing views. Certainly, it's the most dramatic. Besides seeing the Moon in a way unmatched by any photograph, a low-power view shows you in a glance, the color, structure, and relative size of all the major rays. Medium-power eyepieces, on the other hand, work best for examining individual ray systems. However, it's wise to resist using very high magnifications unless the atmosphere holds exceptionally steady. When those moments occur, however, go all-out for the finest details the seeing allows.

Tycho, King of the Rays

No lunar feature is more conspicuous at Full Moon than Tycho's extraordinary system of rays. When the Sun stands low over it, Tycho appears as a rather ordinary, 56-mile-wide crater. But at lunar noon, Tycho is transformed into one of the brightest spots on the disk, neatly contained within a thin, dark halo. The dark halo is really a contrast effect. It results from the crater and its rays being brighter than the ejecta blanket of rocks which lies just outside the rim. These rocks were dredged up by the impact and probably have a composition different from that of the rays. But whatever they are made of, Tycho's long straight rays stand out sharp and clear, even against the bright lunar highlands, and some reach nearly halfway across the Moon.

Rays are geologically transient. The continuing rain of micrometeorites that falls unimpeded on the lunar surface gradually mixes them into the underlying soil. With an estimated age of 109 million years, Tycho is one of the youngest of the major craters and appears bright because its rays are still relatively fresh. Look at Tycho closely. Note how all the rays originate outside the crater and lie somewhat tangential to it.



A RING OF DARKER DEBRIS surrounds the rim of Tycho, while most of the crater's rays lie tangential to its rim. Lick Observatory photo.

Also notice that individual rays are not continuous but consist of a series of overlapping "plumes." Both phenomena suggest that ejecta from secondary craters, not the original impact, may have created the rays.

Tycho has one double ray that extends northwestward, crossing western Mare Nubium. A second seems to run north-northeast all the way to the opposite limb. However, a string of bright craters along the same line tends to break up its length. This ray also appears to divide Mare Serenitatis, but lunar scientists think the ray actually originates at Menelaus, a 20-mile wide crater on Serenitatis' southern shore. Another double ray stretches northeastward to the edge of Mare Nectaris, while farther east, a fourth ray joins up with the bright crater Stevinus. Running south from Tycho, two more bright streaks form a distinctive V, the apex of which lies askew from the crater's geometric center.

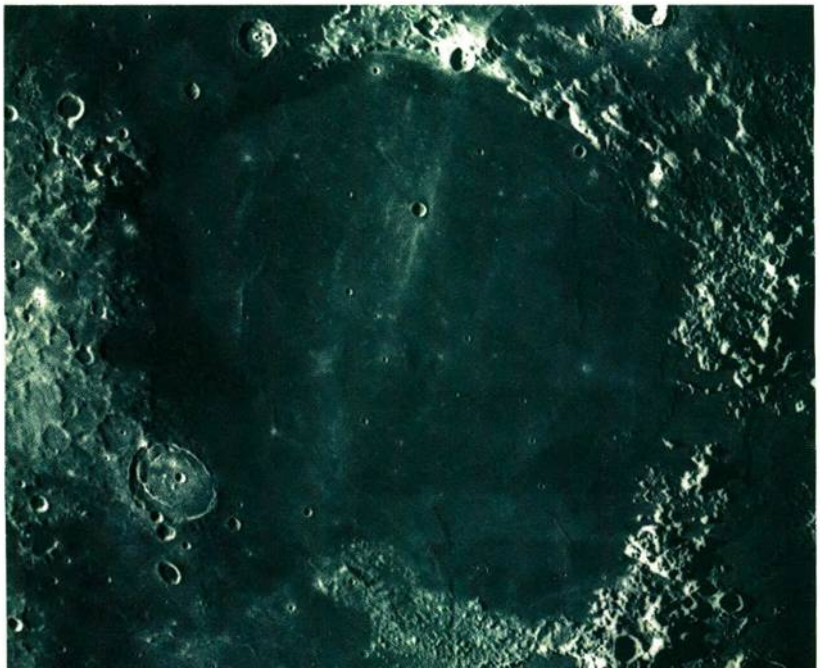
Older, Smaller Rays: Copernicus

Only Copernicus can rival Tycho at Full Moon. Located in Oceanus Procellarum, Copernicus is the oldest of the large ray craters, having formed about 810 million years ago. For a long time lunar scientists could not explain the brightness of Copernicus' rays, which should have faded by now according to theory. But recent studies indicate that the Copernican impact excavated primarily light-tinted highland material, spraying it over the dark mare surface. This could explain the absence of a Tycho-like dark halo around Copernicus, and also suggests the rays will persist for something like another billion years.

Although Copernicus is slightly larger than Tycho, its ray system differs substantially. Its rays are not Moon-spanning streamers but delicate, feathery plumes that for the most part remain on the dark mare plain. You can easily spend hours unraveling the loops and swirls of these gossamer strands or tracing their wavy paths across hundreds of miles of landscape. Southeast of the crater you'll find a curious anomaly — two oval rays. Somehow, the ejecta from the Copernican impact looped backwards here and, as it settled to the surface, formed two well-defined ovals, the larger of the pair embracing the smaller.

Just west-southwest of Copernicus lies 22-mile-wide Kepler. The delicate, spidery rays of this crater closely resemble those of its more imposing neighbor, though the overall pattern appears somewhat elliptical due to the foreshortened view we have of it. Northwest of Kepler, a brilliant spot marks the slightly larger crater Aristarchus. This is the brightest feature on the lunar surface, created by an impact that excavated materials even more reflective than those of the Copernican impact. The white core of Aristarchus completely outshines its rayless companion Herodotus. Surrounding it is a fringe of pale rays, most prominent in the direction of Copernicus and Kepler.

Together, Copernicus, Kepler, and Aristarchus form an almost per-



ONE RAY FROM TYCHO may divide Mare Serenitatis, but some scientists think it actually comes from Menelaus on the mare's south shore. Lick Observatory photo.

fect right triangle on the floor of Oceanus Procellarum. Notice that a number of rays from each crater overlap those of the other two. Moreover, conspicuous double rays connect all three craters. The two between Kepler and Aristarchus run most directly and, although narrow, can be traced the entire distance.

The brighter of the two rays from Copernicus to Kepler appears to continue for some distance beyond the latter. The northernmost of the Copernicus-Aristarchus ray pair is really two rays that merge near the small crater Brayley. Several lunar observers have suggested a connection between this network of interlocking rays and the Tycho system, but the link remains unproven. But the arc of Tycho's great northwestern ray, if extended, does coincide with a line from Kepler to Aristarchus.

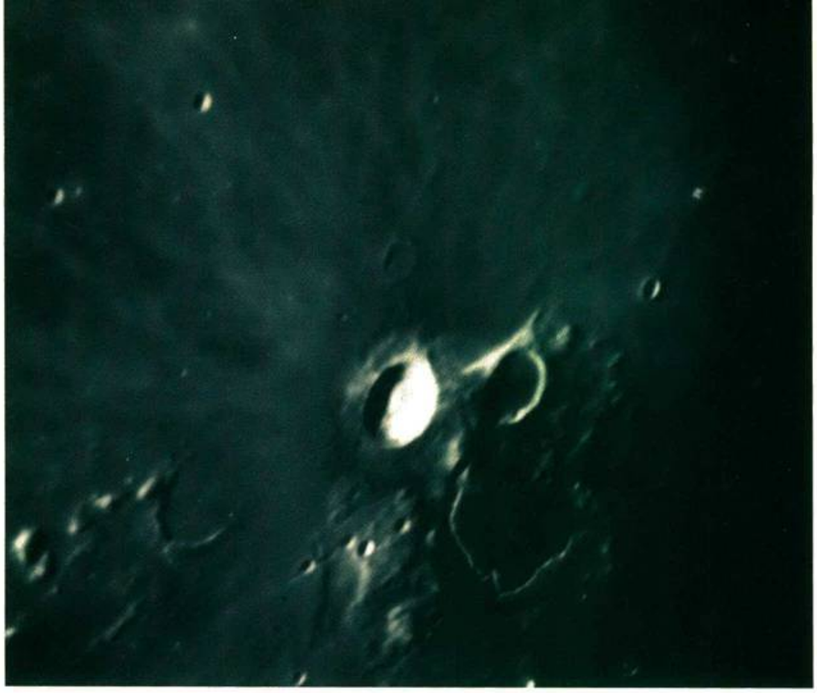
Other Rays, Other Impacts

While the brightest and most intricate ray systems are those associated with Tycho and the Copernicus-Kepler-Aristarchus triangle, dozens more scatter across the lunar surface. Some are bright and easy to observe, others visually challenging. Not all deserve close inspection, but let's take a look at a few that do.

One crater certainly worth looking at is Aristillus, located in eastern Mare Imbrium. Measuring 35 miles across, it is the larger of the two craters just north of Palus Putredinis. Aristillus' rays are most conspicuous to the northwest, where the mare surface is darkest. One long ray straggles toward the dark, smooth-floored crater Plato, while others trail off farther to the west. The second crater, Autolycus, also boasts a retinue of rays, although its system is smaller and paler.

Turn next to the two ray systems dominating the Moon's northern limb. In each case foreshortening severely limits our view. The system to the west emanates from the 33-mile-wide crater Anaxagoras. Its streaks can be traced over the surrounding highland terrain as well as the central portion of Mare Frigoris. The other system originates just above the eastern boundary of Mare Frigoris and belongs to 22-mile-wide Thales. Rays from a companion crater, Strabo, reinforce it.

You'll find two more bright patches along the Moon's eastern limb. Langrenus, on the shore of Mare Fecunditatis, spans 85 miles and is the source of an unusual ray system. Despite the crater's size and relative brightness, Langrenus' rays are narrow and weak and become most evident where they cross Fecunditatis. To the southwest lie the overlapping ray systems of Stevinus A and Furnerius A. Both craters are small, yet their rays are remarkably extensive. To the northwest they reach as far as Mare Nectaris, while to the southwest they sweep past one of Tycho's bright rays.

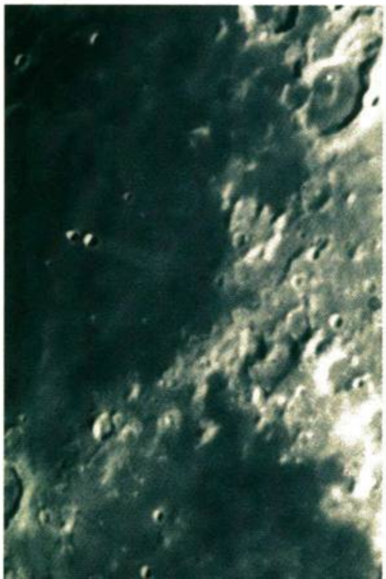


EVEN BEFORE FULL MOON, bright-floored Aristarchus shows a distinct and complex ray pattern. Notice how the rays seem braided. Jean Dragesco photo.

Rays Gone Weird

Every ray system we've seen so far consists of numerous streaks or plumes radiating from a central crater. One noticeable exception to this well-established rule lies in western Mare Fecunditatis. There you'll come across two small craters designated Messier and Messier A. Extending from one side of Messier A, the westernmost of the pair, are two straight, slightly diverging rays, which give the crater a cometlike appearance. According to current thinking, both craters and the trailing rays of Messier A were formed by a single meteorite whose angle of impact was too shallow for the ejecta to disperse radially. Instead, the excavated material shot forward in the same direction as the westward-traveling meteorite.

COMET-RAYS? The twin tails of Messier and Messier A streak westward across Mare Fecunditatis, evidence for a grazing impact. Richard J. Wessling photo.



Observing lunar rays can provide hours of enjoyment for anyone with a small- or medium-sized telescope. If you haven't looked at these remarkable features, you've missed one of the solar system's finest sights. Once you have spent some time tracing individual rays, examining the details of their structure, and watching them brighten and fade with the changing elevation of the Sun, you'll understand why they have fascinated Moonwatchers for centuries.

Besides, what other plans do you have for the next Full Moon? ☐

Edmund Fortier is a longtime observer. His last article was "An Observer's Guide to Sunspots" in the May 1991 issue.

SBIG
ASTRONOMICAL
INSTRUMENTS

WHAT MORE CAN YOU SAY ABOUT A CCD IMAGING CAMERA?

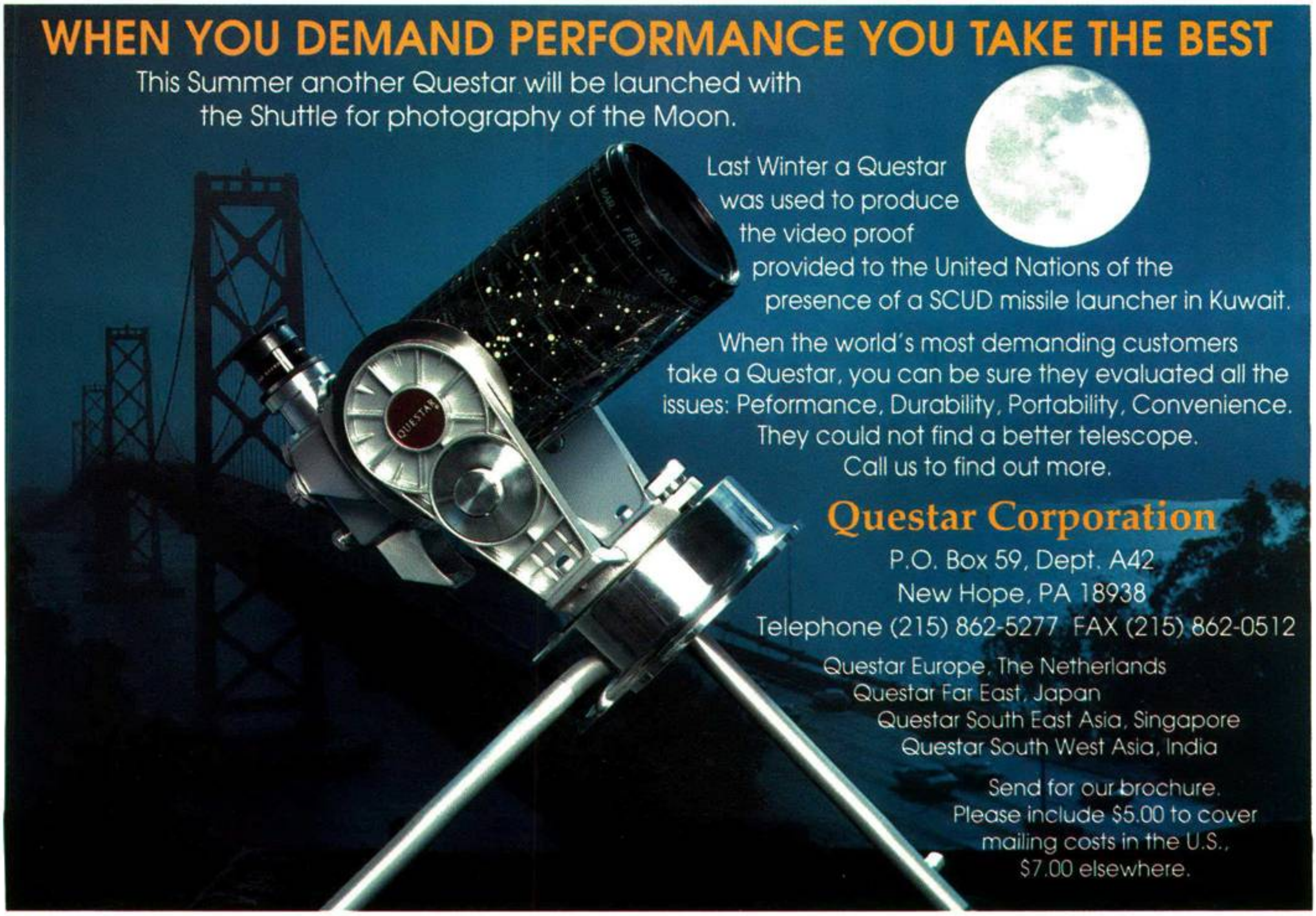
Model ST-6
Second Generation
CCD Imaging Camera $3,000.00

For catalog or demonstration disk contact:

SBIG
ASTRONOMICAL
INSTRUMENTS

SANTA BARBARA INSTRUMENT GROUP
1482 East Valley Road, Suite #J601
Santa Barbara, CA 93108
(805) 969-1851 FAX (805) 969-0299

M16 Eagle Nebula in Serpens. *Five minute CCD image taken at the prime focus of a 25 inch, f/5 telescope. Courtesy of Jack Newton, B.C., Canada.*



WHEN YOU DEMAND PERFORMANCE YOU TAKE THE BEST

This Summer another Questar will be launched with the Shuttle for photography of the Moon.

Last Winter a Questar was used to produce the video proof provided to the United Nations of the presence of a SCUD missile launcher in Kuwait.

When the world's most demanding customers take a Questar, you can be sure they evaluated all the issues: Peformance, Durability, Portability, Convenience. They could not find a better telescope. Call us to find out more.

Questar Corporation
P.O. Box 59, Dept. A42
New Hope, PA 18938
Telephone (215) 862-5277 FAX (215) 862-0512

Questar Europe, The Netherlands
Questar Far East, Japan
Questar South East Asia, Singapore
Questar South West Asia, India

Send for our brochure.
Please include $5.00 to cover mailing costs in the U.S., $7.00 elsewhere.

Comets for the Big Dobs

Observers with 12-inch or larger telescopes can view nearly a dozen comets in the months ahead, while small-scope owners can spot only the brightest.

by Norman Carlson

THE SIGHT OF A DISTANT COMET handsomely rewards a night at the eyepiece. Comet Faye, above, one of the comet's visible this spring, was captured by Edwin Faughn last October.

Remember when a 10-inch reflector drew oohs and aahs at star parties? Now many of us don't even bat an eye at the sight of 12-, 14-, and 17-inch telescopes. The availability of these large instruments has had profound effects on amateur astronomy. For example, instead of being content observing the brightest Messier objects, many backyard observers now search out thousands of faint deep-sky objects.

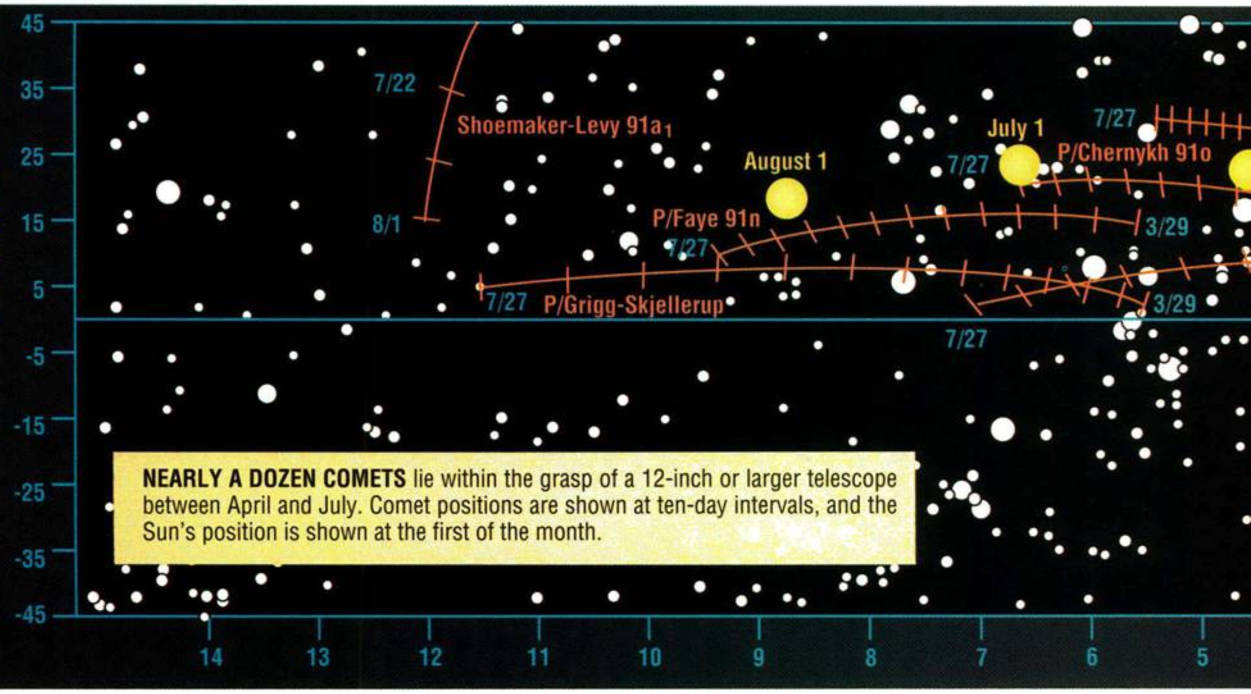
The aperture explosion also can have a major impact on comet observing. Few observers realize that on any given night, three or four comets usually lie within the grasp of a 12-inch or bigger telescope. Observing these faint comets is not the same as viewing bright comets like Halley, West, or Bennett. Most are quite far from the Sun, so it's unlikely you'll see a distinct tail, and the characteristic coma will likely be small. A faint comet typically looks like a faint and fuzzy deep-sky object, except the comet moves from one night to the next.

The next several months are a good time to begin your study of these faint denizens of the solar system. Though we likely won't see any Halley-type comets with intricate dust and ion tails, several fascinating objects invite your gaze.

How about a comet that periodically brightens by 100 or 1,000 times in a matter of days? Or one that has produced meteor storms with up to 32,000 meteors per hour? The sky map on pages 86 and 87 shows the paths of these two comets (Schwassmann-Wachmann 1 and Giacobini-Zinner, respectively) and nine others visible to backyard observers between April and July. At some point during the four months, five of the comets will likely shine at 13th magnitude or brighter — bright enough to see in an 8-inch or smaller telescope — and the rest (except for Schwassmann-Wachmann 1) should be brighter than 15th magnitude. With some luck, an intrepid observer could track down four or five of the comets in a single night. And that doesn't take into account any comets discovered after the magazine went to press or any outbursts from the unpredictable Schwassmann-Wachmann 1.

OBSERVING FAINT COMETS with a big scope is easier than most observers believe. Here the author searches for one with his 18-inch Dobsonian.

COMET FINDER: APRIL TO JULY

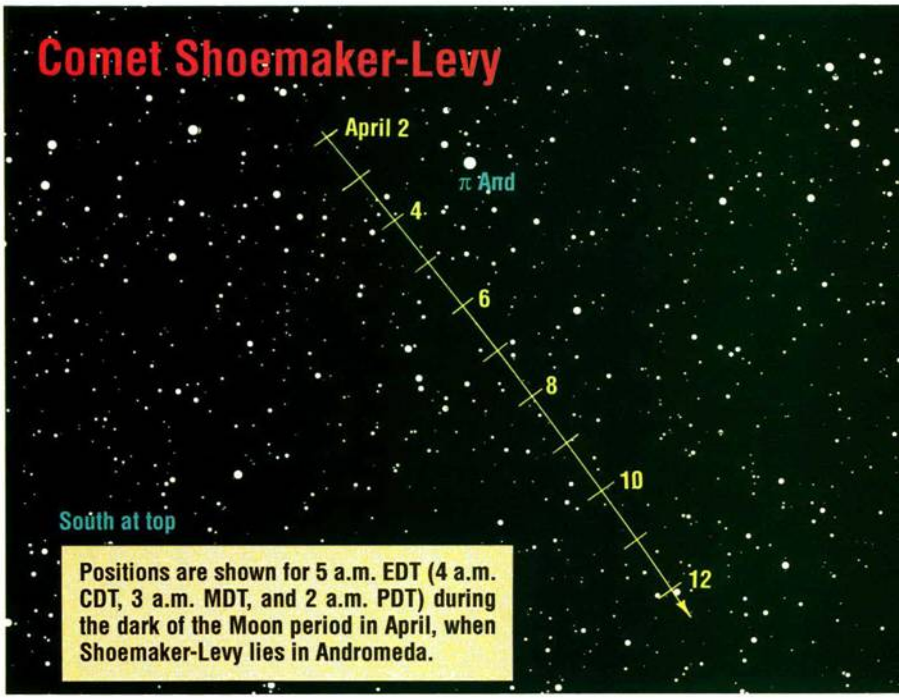


NEARLY A DOZEN COMETS lie within the grasp of a 12-inch or larger telescope between April and July. Comet positions are shown at ten-day intervals, and the Sun's position is shown at the first of the month.

The sky map shows the positions of each comet at ten-day intervals, beginning on March 29 and ending on July 27. Comet Shoemaker-Levy (1991a$_1$) merits a few extra positions because it moves quickly across the sky. The Sun's positions on the first of each month have been added to show when you can expect interference from solar glare. Highlights for the period include:

Shoemaker-Levy (1991a$_1$): Barring any significant discoveries, the brightest comet during this period will be Shoemaker-Levy. (The 1991a$_1$ designates the comet as the 27th discovered in 1991.) Expect this one to approach naked-eye visibility when near perihelion in July. You won't need a big scope to spot Shoemaker-Levy in July, but you will need a big one if you want to get a head start on observing this cosmic interloper in April. The map at right shows where to find Shoemaker-Levy among the background stars of Andromeda. Watch ASTRONOMY's Sky Almanac in the coming months for more info on observing Comet Shoemaker-Levy.

Comet Shoemaker-Levy

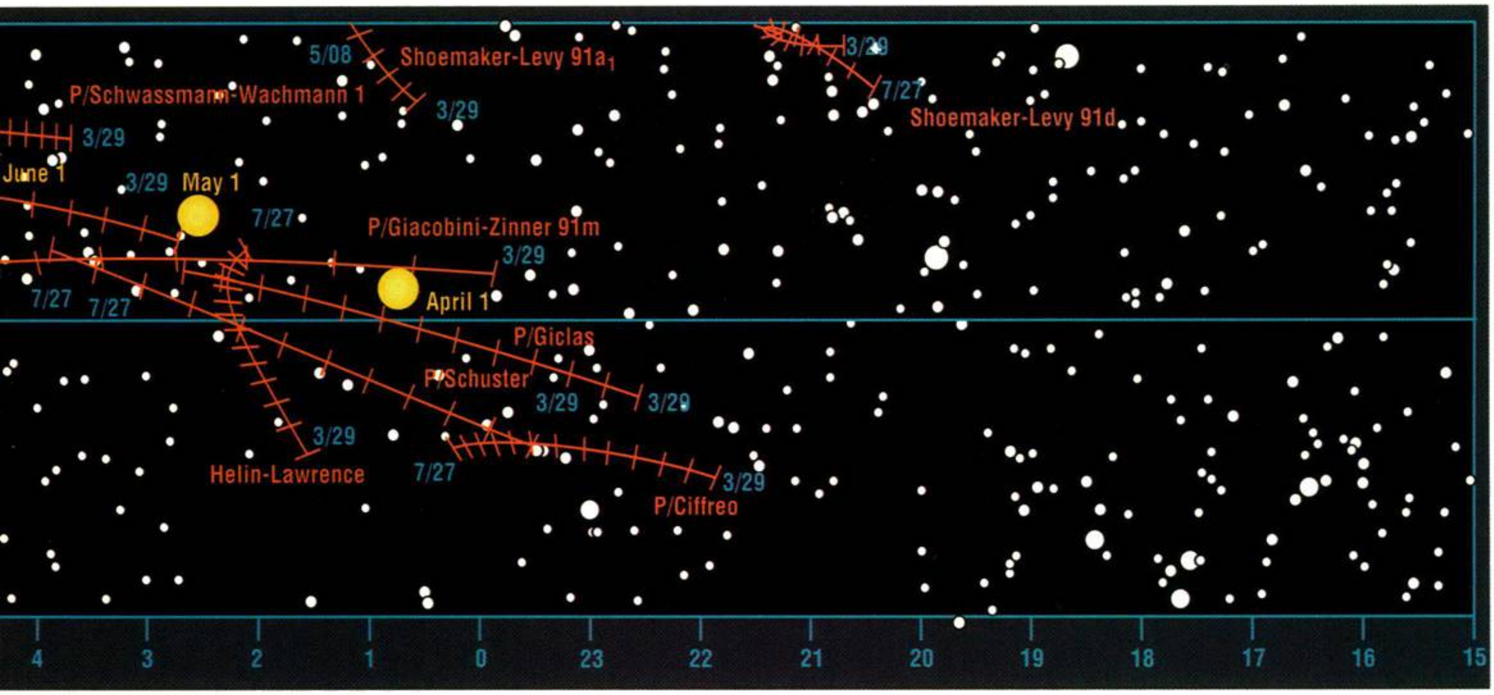


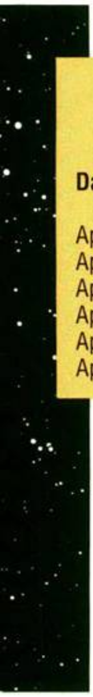
Positions are shown for 5 a.m. EDT (4 a.m. CDT, 3 a.m. MDT, and 2 a.m. PDT) during the dark of the Moon period in April, when Shoemaker-Levy lies in Andromeda.

P/Schwassmann-Wachmann 1: Though astronomers predict this periodic comet (hence the P/ designation) will reach only 18th magnitude during this period, it's included by virtue of its phenomenal outbursts in brightness. During most of these events, which occur unpredictably about once a year (though twice in 1991), the comet's brightness increases by 5 magnitudes. But on three occasions it brightened nearly 9 magnitudes, suddenly glowing at 10th magnitude. If you're lucky enough to catch it during an outburst, you'll be seeing one of the most distant comets visible in backyard scopes. Throughout the April to July period, Schwassmann-Wachmann 1 lies more than 600 million miles from Earth.

Helin-Lawrence (1991l): By mid-June this comet pulls out of the Sun's glare and returns to the morning sky, where it can be glimpsed traversing the constellation Cetus. It should glow then at about 12th magnitude. You can use the map or table of coordinates at right to zero in on Helin-Lawrence during this period.

P/Giacobini-Zinner (1991m): Giacobini-Zinner is not particularly well-placed for observing this spring and summer because its path through the sky parallels the Sun's and it never strays more than 25° from the Sun during this period. But this comet is memorable for the incredible meteor showers (Giacobinids) that result on those rare


5/08
Shoemaker-Levy 91a₁
P/Schwassmann-Wachmann 1
3/29
3/29
3/29
7/27
Shoemaker-Levy 91d
June 1
3/29
May 1
7/27
P/Giacobini-Zinner 91m
3/29
7/27
7/27
April 1
P/Giclas
P/Schuster
3/29
3/29
3/29
Helin-Lawrence
7/27
3/29
P/Ciffreo
4
3
2
1
0
23
22
21
20
19
18
17
16
15

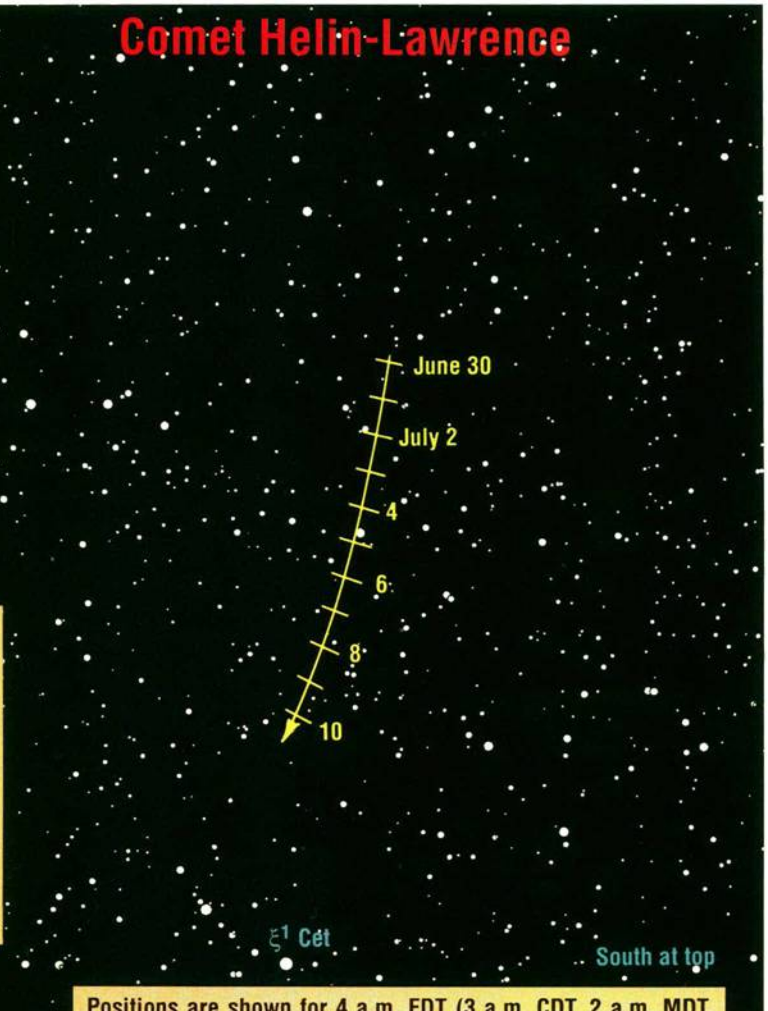


SHOEMAKER-LEVY COORDINATES

Date	R.A. (2000)	Dec.
April 2	0h34.1m	33°36'
April 4	0h35.4m	33°56'
April 6	0h36.7m	34°18'
April 8	0h38.1m	34°40'
April 10	0h35.9m	35°03'
April 12	0h40.9m	35°27'

HELIN-LAWRENCE COORDINATES

Date	R.A. (2000)	Dec.
June 30	2h15.1m	5°47'
July 2	2h14.9m	6°09'
July 4	2h14.6m	6°31'
July 6	2h14.2m	6°53'
July 8	2h13.7m	7°14'
July 10	2h13.2m	7°35'


Comet Helin-Lawrence
June 30
July 2
4
6
8
10
ξ¹ Cet
South at top

Positions are shown for 4 a.m. EDT (3 a.m. CDT, 2 a.m. MDT, and 1 a.m. PDT) during the dark of the Moon period in July, when Helin-Lawrence lies in northern Cetus.

COMET ORBITAL ELEMENTS

	Schwassmann-Wachmann 1	Faye	Shoemaker-Levy (1991d)	Helin-Lawrence (1991l)	Chernykh (1991o)	Giacobini-Zinner (1991m)	Grigg-Skjellerup
Date of Perihelion	Oct 26.7238 1989	Nov 16.1937 1991	Dec 31.2061 1991	Jan 20.0097 1992	Jan 25.4417 1992	Apr 13.2279 1992	Jul 22.1380 1992
Perihelion Distance (q)	5.7718	1.5934	2.2654	1.5178	2.3563	1.0340	0.9947
Eccentricity (e)	0.0447	0.5782	0.9934	1.0006	0.5936	0.70649	0.6643
Argument of Perihelion (ω)	49°.8974	203°.9538	74°.3564	271°.1504	263°.1948	172°.5210	359°.2761
Longitude of Ascending Node (Ω)	312°.1226	198°.8801	144°.4308	11°.1357	129°.7432	194°.6822	212°.6315
Inclination (i)	9°.3674	9°.0910	77°.2987	95°.4531	5°.0821	31°.8280	21°.1042

You can use the above orbital elements in conjunction with one of the many planetarium-type computer programs to calculate the positions of these comets.

COMET GIACOBINI-ZINNER — one of the faint comets visible the next few months, captured here by Martin Germano at its 1985 return.

occasions when Earth passes through the comet's orbit shortly after the comet. In 1933, Earth crossed the comet's path 80 days behind the comet, resulting in a meteor shower with rates up to 1,000 per hour. Thirteen years later, when Earth crossed the path just 15 days behind Giacobini-Zinner, observers saw from 3,000 to 32,000 meteors per hour!

P/Chernykh (1991o): This comet is making its first recorded return since its discovery in 1977. And a dramatic one it's been. Chernykh split in two in September 1991 as it approached its January 1992 perihelion. Unfortunately, Chernykh is fading as it recedes from the Sun and at 14th magnitude will be a difficult object for amateurs.

P/Grigg-Skjellerup: Periodic Comet Grigg-Skjellerup will be visible for only a short time. It brightens from 19th magnitude in early April to 13th magnitude in July and then fades to 19th magnitude again by late October. This comet should become more famous later this year, when the European Space Agency's Giotto spacecraft flies by on July 10, 1992.

Faint, fuzzy comets are difficult to identify because they masquerade as deep-sky objects. To confirm your sighting, you'll have to detect its motion against the background stars. Make a sketch of the stars in your telescope's field of view and add the suspected comet. Then recheck the field the following night. If the object has changed position, it's a comet.

Finding current information on the fainter comets is not always easy. One good source is the handbook published by the Smithsonian Astrophysical Observatory as part of the *International Comet Quarterly*. The handbook usually lists 50 or 60 comets, with positions, for the coming year. For even more timely news, try the *IAU Circulars* from the Central Bureau of Astronomical Telegrams at the Smithsonian Astrophysical Observatory. Amateurs can subscribe to the *Circulars*, which include news bulletins about comets as well as other astronomical subjects. For more information, contact Daniel Green at the observatory, 60 Garden Street, Cambridge, Massachusetts 02138. ☐

Norman Carlson, amateur astronomer and engineer, lives under the normally clear skies of Tucson, Arizona.

KEEPING TABS ON JUPITER AND SATURN

The most interesting telescopic planets — mighty Jupiter and Saturn — put on a great show for observers during the last weeks of 1991. Saturn held fast in the evening sky during December and then slipped toward the horizon as the New Year began. Jupiter was a beacon placed squarely in Leo, rapidly approaching opposition and visible after midnight.

With Jupiter perched so perfectly for observation, it seemed fitting that the giant planet began to perform for its earthbound admirers. In early November observers began to spot blue clouds along Jupiter's equatorial zone. "I began to observe these features with a 10-inch reflector on November 5," says Myron E. Wasiuta of Woodbridge, Virginia. "At the time the bluish color was quite obvious. Several spots were visible at the longitude of the Great Red Spot, and the striking color was best seen as the spots crossed the planet's central meridian."

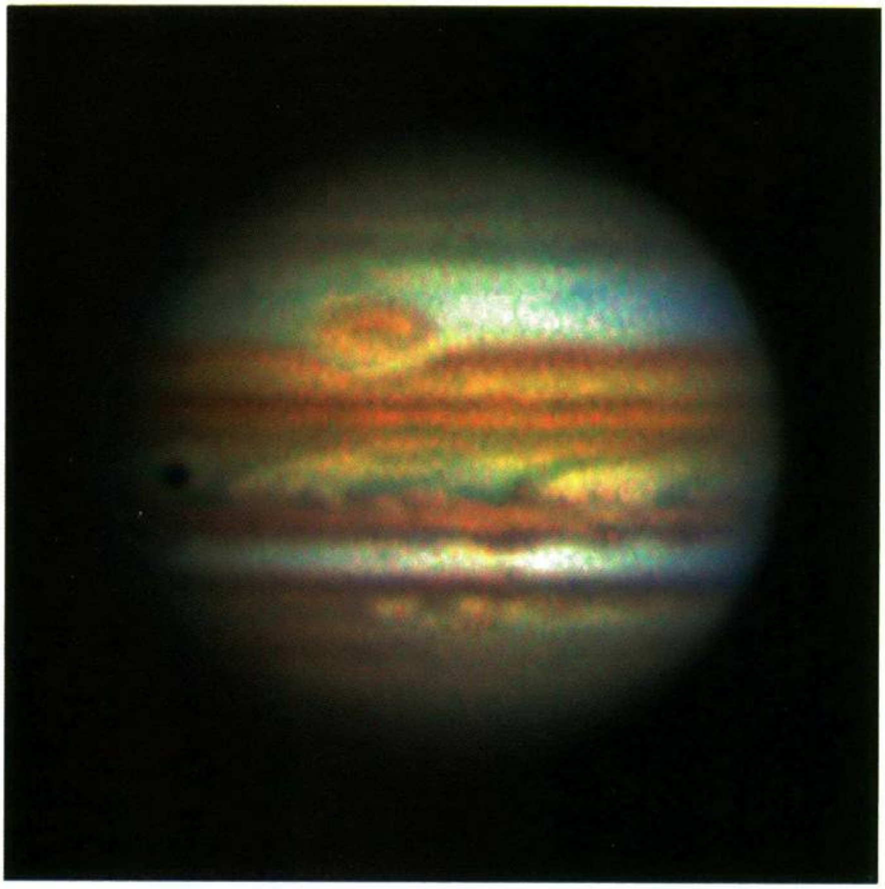
Saturn also captivated observers in late 1991. A group consisting of Matthew Boulton, Paul Smith, and several friends, all of Redditch, Worcestershire, England, monitored the planet and its rings carefully throughout last year's apparition. "Saturn's not like Jupiter," says Boulton, "in that at first it is quite difficult to see detail on the globe and the rings. But after the group's first year of planetary observing in 1987, group members improved their visual acuity and could see subtle detail on Saturn."

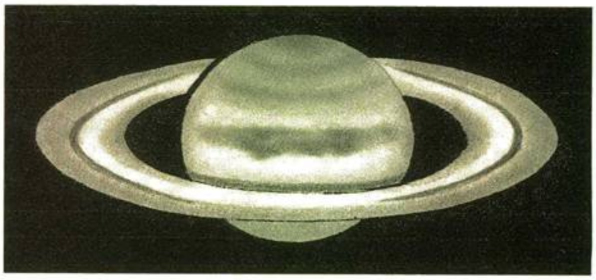
The first detail the observers began to detect was in Saturn's North Equatorial Belt, the North Polar Region, and the North Temperate Belt. Over the next few months Boulton and Smith began to recognize variations in brightness within the ringed planet's belts and zones. Last July they began to notice a brightening in the equatorial zone, which at times appeared brighter than the outer edge of the B ring. They also found great activity within the planet's North Equatorial Belt (NEB), which appeared unusually prominent and displayed detail in telescopes as small as 6 inches in aperture.

"Several observers in our group commented that the southern edge of the NEB appeared rough and irregular at times," says Boulton. "The observing experiences covered a range of sightings. Cliff Meredith of Manchester, England, detected small bright details in the NEB, but didn't have the confidence to commit them to paper. I found the northern edge of the NEB appearing to merge with the adjacent bright zone. However, we observed detail on the southern edge, in the form of gray spots and condensations. Occasionally a hint of a festoon associated with these spots appeared to break out into the equatorial zone.

"All of our observers found filters very useful for observing Saturn," Boulton continues. "The most successful filters were blue and yellow ones, which enhanced marginally faint details."

Boulton and friends will continue to closely monitor features on Saturn and other planets, and we encourage other readers to submit observing reports of their favorite objects too. — *David J. Eicher*





SPOTS, BELTS, AND FESTOONS on Jupiter and Saturn were captured in unprecedented detail by amateur astronomers in 1991. Don Parker's CCD image of Jupiter (top) shows Io's shadow and a wealth of band and festoon structure along the planet's equator on December 4, 1991. Matthew Boulton sketched Saturn (bottom) with a 6-inch scope on August 12, 1991, showing connected spots along the planet's North Equatorial Belt.

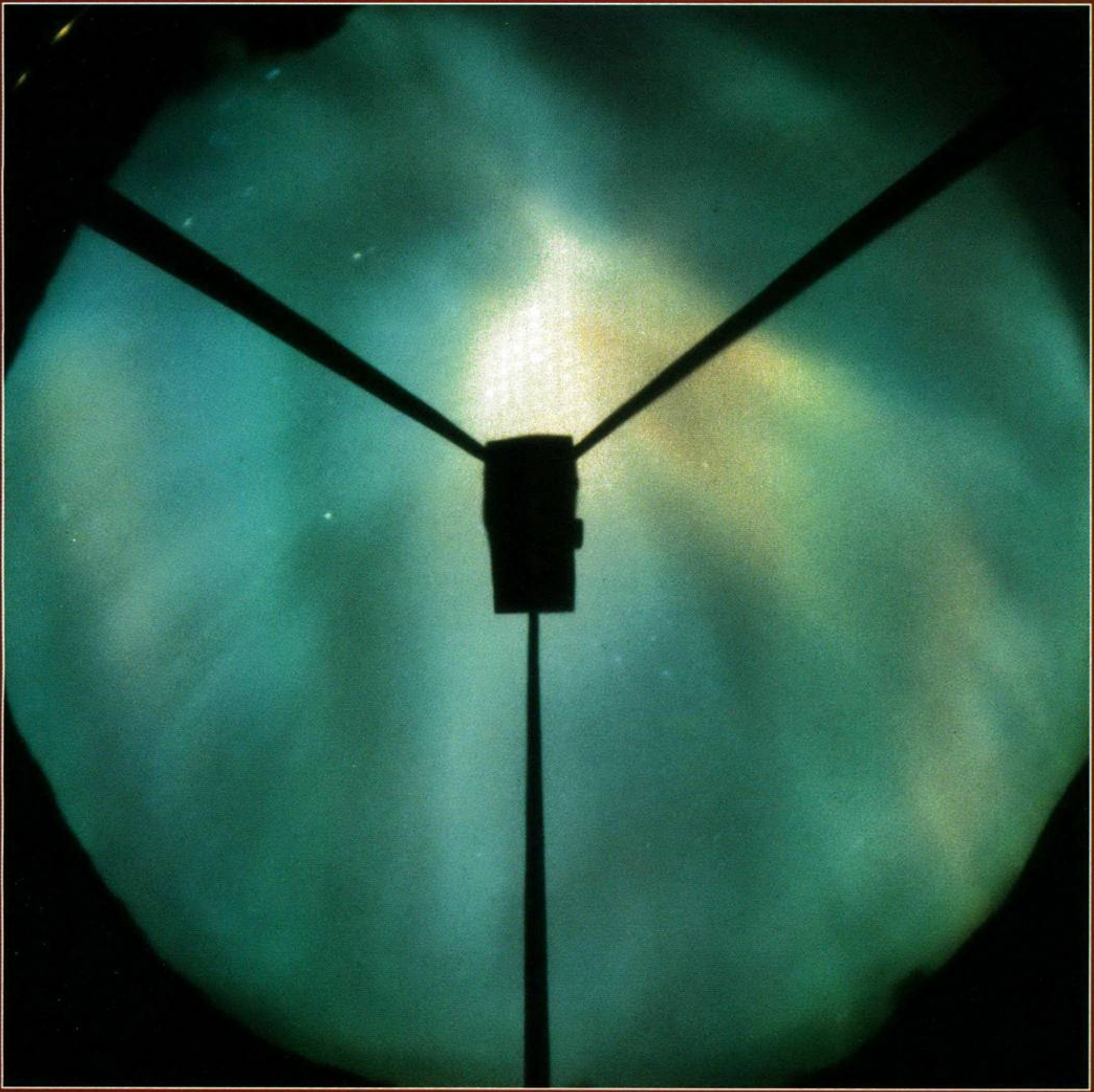
A MAGNIFICENT STORM FROM THE SUN

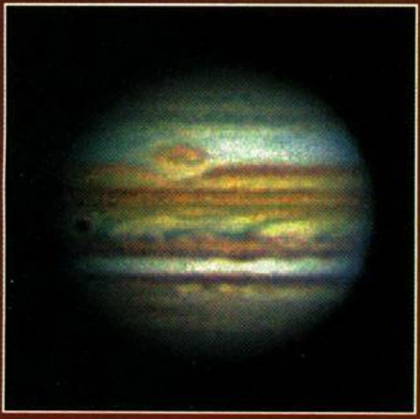
Peter Zaffo's all-sky photograph of the November 8, 1991 aurora (opposite page) wins this month's $100 "Best Astrophoto" award. Zaffo used an all-sky camera from Warrensburg, New York, taking the picture at 11:25 p.m. EST.

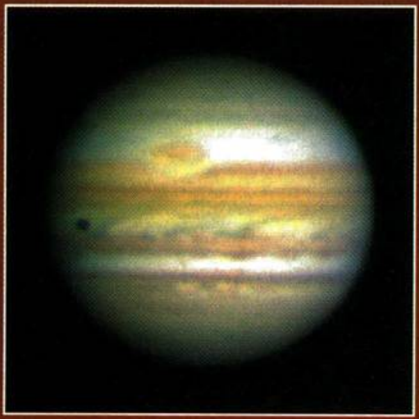
Meteors, comets, and planets also captured the attention of backyard astronomers late last year. A bright bolide meteor flashed through the field during Charles Klimitchek's exposure of the North America Nebula (below). (The short streak just below the nebula is a reflection caused by the camera's skylight filter.)

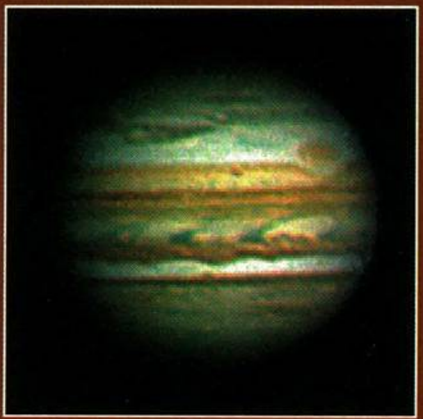
Experienced imager Don Parker of Coral Gables, Florida, used his 16-inch telescope and CCD camera to record three images of Jupiter, two on December 4 and one on December 10 (opposite page, bottom). The image processing was done by Richard Berry using Astro IP.

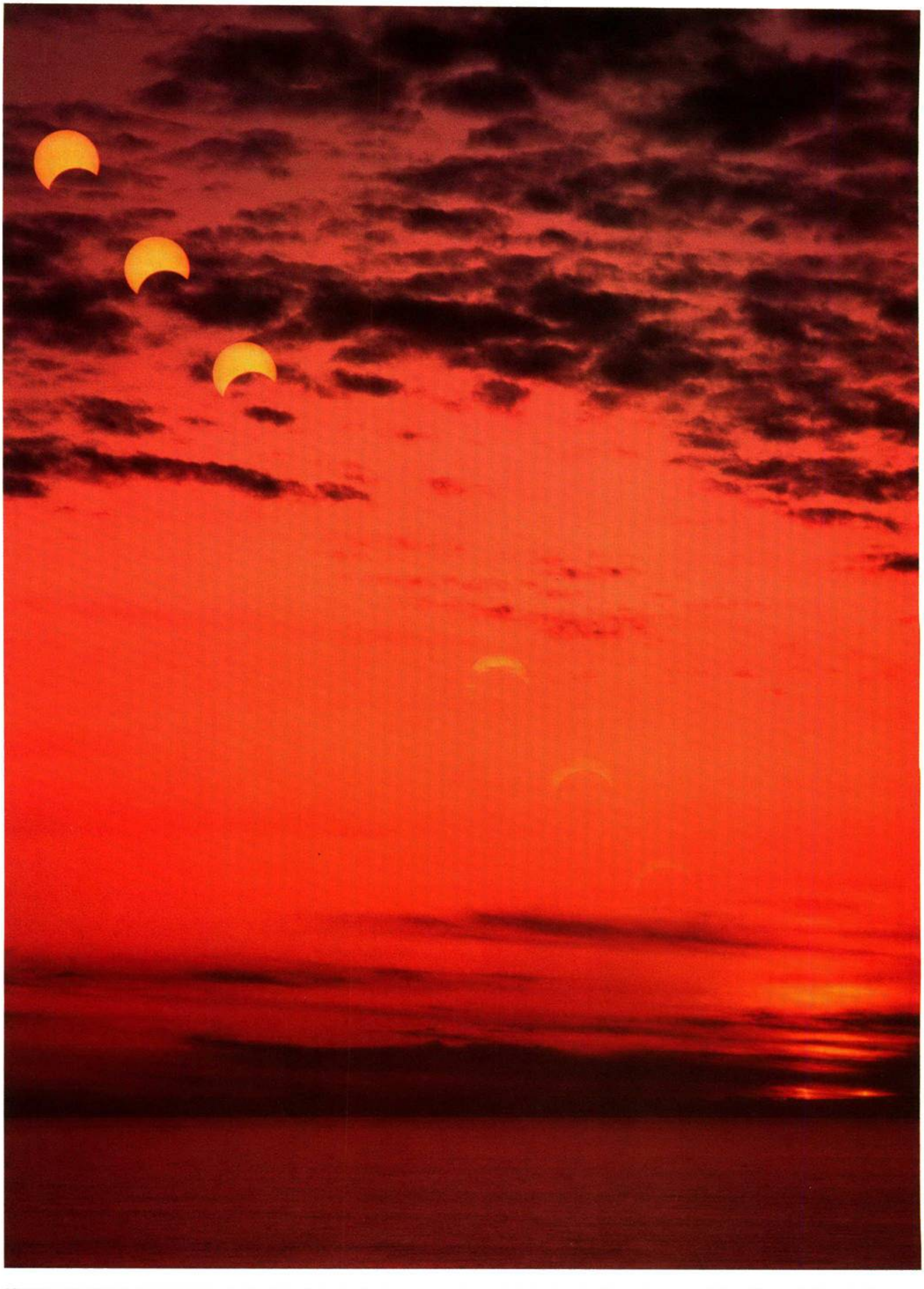
In mid-September 1991 Comet P/Faye whizzed past the spiral galaxy M74 in Pisces. On the 16th Gerald Rhemann of Vienna, Austria, captured the pair in a single frame (left).











JANUARY'S ANNULAR ECLIPSE slowly sinks into the horizon as photographed by James Glenn Pearson of San Diego, California. Pearson used a 360mm f/6 lens, a glass solar filter, Fuji Velvia film (ISO 40), and ten exposures spaced at five-minute intervals.

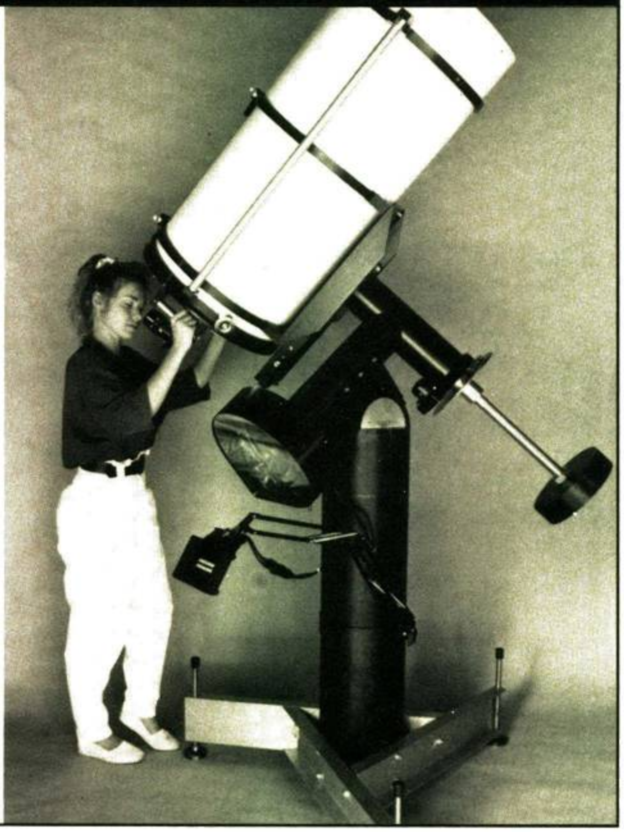
THE RITCHEY-CHRETIEN ADVANTAGE

COMPLETELY
COMA-FREE IMAGES!

Professional astronomers require crystal-clear viewing. That's why they and state-of-the-art observatories demand the Ritchey-Chretien advantage. You, too, can achieve coma-free viewing and astrophotography (where stars *look* like stars, not comets or sea gulls!) with Optical Guidance Systems high-performance R-C telescopes.

Available from 10-32 inches
Shown: 16" f/8.4 on HP75 mounting --- $14,350
16" Classical Cassegrain $12,200 – 16" Newtonian $11,395

Optical Guidance Systems
2450 Huntingdon Pike, Huntingdon Valley, PA 19006
215-947-5571



Authorized Meade Dealer

Meade

TELESCOPES

Accessories, Binoculars,
Books, Maps, Charts,
Software,
etc.

FREE Freight
(UPS ground, in the 48 states)

FREE Price List
(send self-addressed, stamped envelope)

California Telescope Company

To order, or for information, call (818) 505-8424. MasterCard, Visa, DiscoverCard, & interbank wire transfers accepted - no surcharge. Most items free UPS ground shipping in the contiguous 48 states. California shipping addresses add sales tax. Send business-sized SASE for free Discount Price List; for Catalog Package send $5 ($8 foreign), check or MO only. RFQ's welcome. Prices and specifications subject to change without notice or obligation. Astronomy AS91-06MA

Export Sales, Government, Institutional & Commercial Accounts WELCOME. For info, call:
(818) 505-8424
24 Hr. FAX: (818) 980-9331

P.O. Box 1338, Burbank, California 91507
10-4 Pacific Time, Mon-Fri:
(818) 505-8424

OUR GUARANTEE: We are solely, exclusively, professionally, a first-line, quality telescope dealership. We guarantee, unconditionally, that when you purchase a telescope or other item from us, you will receive all of the equipment and accessories that its manufacturer specifies for it. ***We do not*** "strip" scope kits, ***nor do we*** charge extra for the equipment, accessories or warranties intended by the manufacturers to be included with their equipment. When you buy from us, you will receive everything you pay for - you can count on it. We further guarantee, unconditionally, that all equipment sold by us is brand-new and factory-fresh. ***We do not*** take unscrupulous advantage of distant and helpless mailorder buyers; ***we do not*** buy and ***we do not*** sell ***RETURNED***, reconditioned, rebuilt, demonstrator, floor-sample, shopworn, used, loaner, rental, prototype, cosmetic defect, factory-second or otherwise imperfect goods. Don't let yourself be fooled - buy only from a knowledgeable, reputable, dealer.

ODYSSEY
TELESCOPES
Seeing the *real* Universe

FREE INFORMATION
- ODYSSEY GUIDE
- OWNER COMMENTS
- REPRINTS
- DOBSONIAN INFO.
- COULTER OPTICAL NEWS
- PRODUCT LIST

ASK FOR IT!

8 inch $275.00

"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby."
David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years."
Tom Johnston, Boulder, Colo.

10.1 inch $345.00

"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)."
Lee Johnson, Coquitlam, B.C. Canada

13.1 inch $575.00

"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms any thing that I have seen!!"
Richard Ziegler, Maumee, Ohio

"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides."
Mark Davenport, Pinellas Park, Fla.

17.5 inch $1150.00

"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbara, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion." David Broad, Santa Barbara, Ca.

Lightweight Mirror Optics at Low, Low Prices:
Aluminized & overcoated

10 inch f/5.6	$150.00
10.1 inch f/4.5	$155.00
12.5 inch f/6	$287.50
13.1 inch f/4.5	$295.00
17.5 inch f/4.5	$675.00

Elliptical Diagonals

1.83" — $17.95	3.10" — $ 39.95
2.14" — $21.95	4.25" — $ 79.95
2.60" — $25.95	6.25" — $200.00

EASY TO ORDER . . . Phone or mail your order in today. Visa/MasterCard accepted. All telescopes are shipped freight charges collect. All mirrors are shipped prepaid in the contiguous U.S.A. No sales tax on out-of-state orders. Phone orders Mon-Fri 8 am-4:30 pm local time. Call 1-714- 659-4621

- **30 days returnable**
- **30 days exchangeable**
- ***2 years materials and workmanship***

© Coulter Optical, Inc.

P.O. Box K
Idyllwild, CA 92349-1107
"OPTIMUM OPTICS AT MINIMUM COST SINCE 1967"

SHARPEN YOUR PLANETARY VIEWING SKILLS

Seeing the Solar System, by Fred Schaaf, (John Wiley, 1991), ISBN 0-471-53071-9, 208 pages, paperback, $14.95.

Intended for the novice stargazer equipped with a telescope, this book consists of 53 projects designed to teach how to observe the nearby part of the universe: the Sun and its family of planets. The book's clear aim is to help the reader become a better observer with a sharper astronomical eye.

More specifically, 18 projects cover the Moon, the Sun, and eclipses. These explore, among other subjects, sunspots, the features of the Moon (3 projects), lunar occultations of stars, and solar and lunar eclipses. Twenty-eight more projects examine the planets and their features, including Jupiter's clouds, the Great Red Spot, Venus' clouds and the ashen light, Saturn's rings, Martian ice caps, and so on. Six final projects cover comets, asteroids, and telescopic meteors.

The projects are similarly structured, beginning with a "what you are to do" paragraph, followed by the steps to take. Schaaf's easy style makes the projects something any interested beginner could follow. He works historical details in with technical data to give you what you need to know. Questions at the end of projects get you thinking about what you have observed and encourage you to see more.

Will an experienced observer benefit from the book? That depends on skill. An amateur astronomer for years, I learned several new observational skills and reacquainted myself with some that had fallen into disuse. If you know a budding astronomer, get the book — but take a look through it before you give it away. You might well want a copy for yourself. — *Robert A. Garfinkle*

Solar System

Mars and the Development of Life, by Anders Hansson, (Ellis Horwood, 1991), ISBN 0-13-559022-1, 144 pages, sewn binding, hardcover, no price given.

When the Viking landers failed to detect life on Mars in 1976, scientific interest in the question dwindled sharply. In the years since, however, new studies of the history of Mars, particularly its earliest periods, have reawakened the possibility that Mars may have once had life even if the planet is dead now. Hansson probes this question, examining the results and the limitations of the Viking data. He explores the history of the Martian climate (to the extent known) and assesses the chances for at least early Martian life, which are good enough that we should make an intensive search for traces of it. Hansson concludes the major problems are technical (getting to Mars), but the scientific payoffs in learning how life may begin — on Earth and elsewhere — are enormous.

Galactic Astronomy

Journey to the Center of the Galaxy, by Joel Davis (Contemporary Books, 1992), ISBN 0-8092-4242-7, 335 pages, hardcover, $22.95.

Davis' *Journey* is actually three journeys. The first section looks at how science fictioneers from the 1950s until today have envisioned the center of the Milky Way Galaxy. The second examines mankind's evolving view of the Milky Way from the earliest speculations of the Sumerians to today's latest astronomical results. The third starts at the Galaxy's outer rim and plunges inward on an imaginary trip to the galactic core as known today.

Observing Helps

Cambridge Star Atlas 2000.0, by Wil Tirion, (Cambridge University Press, 1991), ISBN 0-521-26322-0, 74 pages, sewn binding, hardcover, $19.95.

Twenty charts, each about 8 inches by 11, cover the entire celestial sphere. Together they show about 9,500 stars (as black dots on a white sky) down to magnitude 6.5, plus some 866 non-stellar objects such as nebulae, clusters, and galaxies. Opposite each chart is a list of interesting objects by type. The Milky Way's extent is portrayed in a blue tint that becomes dark gray under red light. (The stars and designations are legible through the gray.) The atlas also contains 12 monthly star maps suitable for use in Northern and Southern Hemispheres, six all-sky maps showing the distribution of galaxies, nebulae, and the like, and an introductory text that explains different types of stars and non-stellar objects.

LOS ANGELES OPTICAL

Telescopes, binoculars and accessories are our *only* business.

We feature a large showroom display of better-quality, major-brand instruments and accessories from such established, nationally-known manufacturers as:
Meade, Celestron, Bausch & Lomb, Bushnell, Edmund, TeleVue, Lumicon, Fujinon, Zeiss, Leitz, Swarovski, Steiner, Bogen etc.

Huge selection of astronomy books, maps, charts, software, etc.

Friendly, helpful, knowledgeable, non-commissioned sales staff.

Everyday low discount prices.

Meade's
Premier
Series

Authorized Meade Dealer

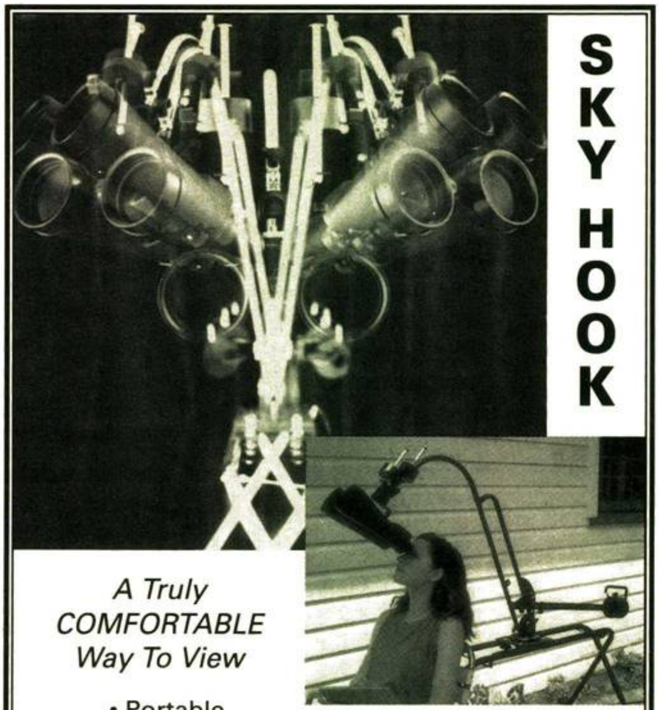
LOS ANGELES OPTICAL COMPANY

LOS ANGELES OPTICAL COMPANY
MAGNOLIA
BOULEVARD
LAUREL
CANYON
N
VENTURA
FWY
101
134
170
HOLLYWOOD
101

"Telescopes and Binoculars are our *only* business"

12129 Magnolia Boulevard
(NW corner, at Laurel Canyon)
North Hollywood, CA 91607
818-762-2206
Hours: 10-6, Mon-Sat
Free, Convenient, Off-Street Parking
MstrCard - VISA - DscvrCard - AMEX

ASLA9104 Astronomy - April, 1991



A Truly COMFORTABLE Way To View

- Portable
- Set up in less than a minute
- $345.00 (U.S. Funds) plus shipping

STAR-BOUND T.M.

68 Klaum Avenue • North Tonawanda, New York 14120
Tel. (716) 692-3671 • Fax (716) 693-8713

WHOLESALE OPTICS OF PENNSYLVANIA *For All Your Astronomical Needs*

EDMUND SCIENTIFIC
Astro Scan 2001
4¼" Port. Reflector Scope
$287.00
(See Edmund Eyepieces & Acces. listing in this ad)
Ideal first scope or portable second. Goes everywhere. IN STOCK for immediate delivery.

Tele Vue Eyepieces, Genesis and Accessories — Sale Priced!

All Plössls, Widefields & Naglers IN STOCK

New for 1992 22MM 1¼" & 35MM 2" Panoptic Eyepieces

NEW PRONTO SCOPE NOW AVAILABLE

Genesis for 1992
For the most impressive view of Star Clusters and Nebulae, for startling sharpness in viewing the moon and planets — the 4 element Genesis with fluorite lens and 101MM clear aperture is the instrument of choice, in stock for immediate delivery!

TELRAD
w/Base $39.00
Batteries Included!

Extra Reticles	$2.95
Extra Bases	$7.95
Hinged Deluxe Dew Caps	$10.00

JIM'S MOBILE

Moto-Focus LX3/5/6	$78.00
Moto-Decs LX3/5/6	$75.00

Moto-Focus and Moto-Decs for all scopes avail. Contact us for special sale prices on NGC Mini Max, NGC Max, DSC and SGT Max. **New — NGF-2**
Deluxe Focuser (used on NGT's) with or without Motor focus Now Available.

B&L 8x50 FINDER St. thru $48.00
MOUNTING BKTS. Spec. SCT or Newt. $28.00
6x30 Rt. Angle Finder $44.95
6x30 Bracket $18.00

8" Reflector on Dobsonian Mount
- Full thickness Mirror • 6x30 Finder
- 1¼" Rack & Pinion Focuser
- RKE Eyepc. — Your Choice of FL

Telrad can be substituted in place of finder **$489.00**

SOLVE FOCUS PROBLEMS FOREVER
with Spectra's Sure-Sharp Optical Grid Focusing method for perfectly focused astrophotos.
All Spectra accessories avail. **$129.00**
Rt. Angle viewer **$44.50** Duo-View **$74.50**

QUARTZ DRIVE CORRECTORS BY VOGEL — ALL DIGITRAK II

SINGLE AXIS		DUAL AXIS	
VE-200 Runs off DC	$132.95	VE-200 D	$174.95
VE-300 Runs off DC/AC	$159.95	VE-300 D	$212.95
VE-400 Runs off DC/AC or Int. Battery	$198.95	VE-400 D	$262.95
		VE-100 Inverter (converts your motor to DC)	$71.95

PORTA-PAC $65.00
12 AMP HR.
Heavy Duty
PORTA PAC....$86.95

Tectron Collimators improve Newtonian images w/the following

Sight Tube	$29.00	Auto-collimator	$31.00	New "Revised" Booklet on Collimation	$6.00
Cheshire Eyep.	$38.00	Above 3 w/Bklt	$95.00		

For that Fast New Scope your building or for upgrading your current scope —

Ultra Low Rack & Pinion Focusers 2" w/1¼" Adptr.	$125.00
Photographic Focuser	$159.00

BOOKS & STAR CHARTS

MAG 5 Star Atlas	$6.95
MAG 6 Star Atlas	$16.95
1000 Plus	$39.95
Sky Atlas 2000 Field	$16.95
Sky Atlas 2000 Desk	$16.95
Sky Atlas 2000 Color	$39.95
Laminated Deluxe 2000 Color	$84.95
Laminated 2000 Field or Desk	$59.95
Burnham's Handbook — All 3 Volumes	$35.85
Norton's Sky Atlas	$34.95
Uranometria Vol. I or II	$39.95

Full line of astronomical books & publications avail.

FYEPIECE SPECIALS

Meade 7MM R. Gr. Ortho	$45.95
11/4" 16.3MM Erfle	$50.00
11/4" 25MM Erfle	$59.00
11/4" 32MM Erfle	$50.00

***11/4" Kellners on Sale from $26.00**
***11/4" Ortho's on sale from $39.00**

2x11/4" Barlow	**$36.00**
12.5 Wireless Illum. reticle Plössl	**$95.00**
9MM Wireless Illum. reticle Plössl	**$116.00**

***Contact us for particular focal lengths .96 sizes also available**

BINOCULAR SALE!
We carry Zeiss • Fujinon • Alderblick • Swarovski • Steiner • Swift • Minolta • Celestron • Aus Jena • Meade • Kowa • B&L

Fujinon 7 x 50 FMT-SX	$365.00
10 x 70 FMT-SX	$439.00

THOUSAND OAKS SOLAR FILTERS THE BEST!
Enjoy continued high solar activity.

Type I 8"	$84.95	Type II 8"	$114.95
Type I 10"	$94.95	Type II 10"	$124.95

ALL sizes available for all scopes. Type III and new thread ins avail.

EDMUND SCIENTIFIC EYEPIECES & ACCESSORIES

1¼" RKE 8, 12, 15, 21 or 28MM	$39.95
RKE 2.5X Barlow	$61.95
1¼" Orthos 4, 6, 12.5, 18 or 25MM	$49.95
Ortho Zoom 8.4-21MM	$91.95
1¼" Kellners 6, 9, 12, 18 or 25MM	$33.95
1¼" Erfle 20MM	$54.95
2" 32MM Wide Field Erfle	$119.00

Astro Flashlights

Red Led Chartmaster			$19.00
Small Setup	$8.00	Large Setup	$12.00

ASTRO-SCAN ACCESSORIES:

Tripod Bkt.	$38.95	Tote Bag	$27.95
Variable Cam. Ad.			$64.95
St. Thru Image Erector			$54.95

ALL EDMUND PRODUCTS AVAILABLE

ACCESSORIES CORNER

T-Rings (spec. camera make)	$10.00
Tele-Extenders for SCT's	$22.00
T-Adapters for SCT's	$22.00
Color & Moon Filters	$13.00
Set of 6 Filters 1.25"	$59.95
Drives for Tasco Eq. Mount	$89.95
Anti-Vibration Pads for Tripods	$45.00
Tripod Slo-mo controls	$46.00
New Deluxe Optics Cleaning Kit	$19.00
Celest. F6.3 Reducer/Corrector	$139.00
Celestron .96 Star Diagonal	$19.95
Celestron Photo Deluxe Tripod	$95.00

LUMICON Deep Sky UHC H-Beta OX III in stock

All Parks optics, mirrors & access.
We also carry Kowa and Mirador Spotting Scopes
We're now dealers for D&G Optics Refractors, Opto-Data Starport, Tech 2000 Dob. Drivers & Bogen Tripods

ATTENTION ASTROPHOTOGRAPHERS
BEATTIE INTENSCREEN — PLUS
Ultra bright focus screens for:

Olympus OM-1,2,3,4	$53.95
Nikon FE, FE2, FM2, FA	$53.95
Nikon F, F2, F3	$88.95
Canon EOS	$63.95
Canon T-90	$63.95

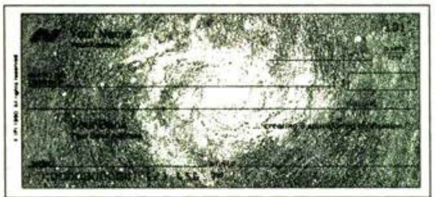
MEADE • CELESTRON • TELE VUE • B&L • BRANDON • PARKS • EDMUND • UNIVERSITY OPTICS • JMI • THOUSAND OAK FILTERS • QUESTAR TECTRON • EDMUND SCI • FUJINON • ZEISS • SWIFT • VOGEL all at Fantastic Savings

Wholesale Optics of Pennsylvania

Wholesale Optics of Pennsylvania
North Pocono Village Shopping Center
RR 6, Box 6329, Moscow, PA 18444
Showroom Hours, 10-6
Call till 9 PM: (717) 842-1500
FAX 717-842-1408 24 hrs.
P. List send SASE
3% Cr. Cg.
Cat. $4.00
Speak with amateur astronomers . . . Ask for Glenn-ARS: K3WEI
★ *WORLDWIDE SHIPPING* ★
$5.00 MIN. SHIPPING — U.P.S. (IN U.S.)

ASTRONOMICAL LEAGUE

FULL COLOR SPACE CHECKS
4 different designs. Only $12.95 for 200 checks
Acceptable with your account at any financial institution in the country.
Satisfaction Guaranteed!



Send Your Order To: IMAGE CHECKS
P.O. Box 4219 Denver, Colorado 80204
Questions? Please call 1-800-477-CHEX
© IPI 1991. All rights reserved. Registered with the U.S. Copyright Office.

Easy To Order. Use This Coupon.
Include a voided check or a reorder form from existing supply of checks. Make check payable to Image Checks. Allow 3-4 weeks normal delivery.
***IMPORTANT:* Indicate check start #** ________

ONE-PART CHECKS (check one)
☐ 1 box (200 checks) $12.95.
☐ 2 boxes (400) $24.90. **Save $1.00**
☐ 4 boxes (800) $47.80. **Save $4.00**

– OR – AS4/92

DUPLICATE CHECKS (Makes carbonless copies)
☐ 1 box (150 checks) $14.95.
☐ 2 boxes (300) $28.90. **Save $1.00**
☐ 4 boxes (600) $55.80. **Save $4.00**

Amount of order $ ________
Shipping and Handling $ 2.00
Priority Mail add $3.50 (optional) $ ________
Total amount enclosed $ ________

Save up to 33% on your next subscription to ASTRONOMY.

Here's a special offer to save on ASTRONOMY magazine – but only if you're an astronomy club member.

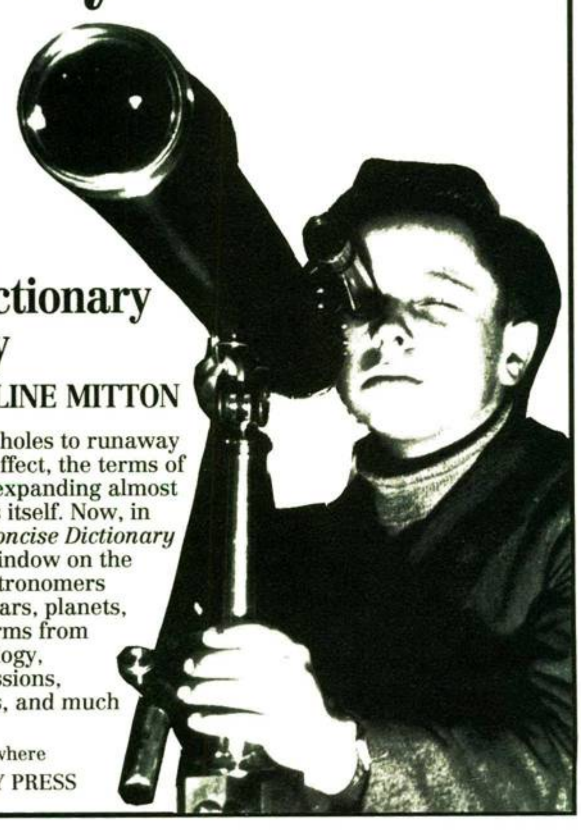
Save up to 33% off the regular subscription price when you subscribe through a club. See the May 1991 issue of ASTRONOMY for an astronomy club near you.

MEMBERS ONLY

ASTRONOMY
Call (800) 446-5489
(weekdays 8:30 a.m. – 5:00 p.m. CST)

Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612

Astronomy from A to Z



A Concise Dictionary of Astronomy
Edited by JACQUELINE MITTON

From blazers and black holes to runaway stars and the Hawking effect, the terms of modern astronomy are expanding almost as rapidly as the cosmos itself. Now, in some 2,400 entries, *A Concise Dictionary of Astronomy* opens a window on the universe for amateur astronomers everywhere. Here are stars, planets, moons, and galaxies, terms from astrophysics and cosmology, observatories, space missions, abbreviations, acronyms, and much more.

At bookstores everywhere
OXFORD UNIVERSITY PRESS

Astrophotography for the Amateur, by Michael Covington, (Cambridge University Press, 1991), ISBN 0-521-40984-5, 168 pages, paperback, sewn binding, $16.95.

This is the paperback edition of an excellent guidebook to the basics of astrophotography first published in 1985. Covington has brought the text up to date to reflect advances in film speeds and techniques.

Astronomical Computation

Methods of Orbit Computation for the Micro Computer, by Dan Boulet, (Willmann-Bell, 1991), ISBN 0-943396-34-4, 565 pages, sewn binding, hardcover, $24.95.

In the last 10 years, celestial mechanics has emerged from an arcane realm to one where anyone with a microcomputer can perform surprisingly complex calculations easily. Boulet aims to let beginners determine the orbits of planets, comets, and Earth satellites. The approach is straightforward, with many BASIC program listings. At least one worked example accompanies each program. All the programs assume an output to the computer's monitor, although they can be modified easily to output to a printer or a data file.

Astronomical Algorithms, by Jean Meeus, (Willmann-Bell, 1991), ISBN 0-943396-35-2, 429 pages, sewn binding, hardcover, $24.95.

This is the latest version of a work first published in 1978 as *Astronomical Formulae for Calculators*, but in this form it is really a new book altogether. Meeus provides algorithms for some 56 specific calculations. These include iteration, sidereal time at Greenwich, lunar phases, eclipses, and sundials, to name a few. Note however that these are mathematical routines, not programs: Meeus provides the equations, but you have to write the software. As a help on checking your results, he provides many worked examples.

Reference Works

History of Rocketry and Astronautics, edited by A. Ingemar Skoog, (American Astronautical Society, 1991), ISBN 0-87703-330-7, 311 pages, paperback, no price given.

Twenty-four papers examine aspects of rocketry's history, including rockets in 16th-century Sweden and ancient China. Most of the papers, however, cover 20th-century developments in the United States, the former Soviet Union, and Europe. ☐

ASTRONOMY Blue Sky Pages

Your guide to local astronomical dealers

ARIZONA

TUCSON'S COMPLETE ASTRONOMY SHOP

- New and Used Equipment from Celestron to Questar & Accessories
- Books, Posters, Maps & Star-Charts
- Custom Work-Machine & Wood Shop Work Available
- Observatory Construction & Repair
- Observing site and tour guides available.
- Rental equipment available – call for details.
- Repair Work-Telescope Cleaning & Collimating
- Knowledgeable Professional Staff

Stellar-Vision & Astronomy Shop
1835 S. Alvernon #208,
Tucson, AZ 85711 (602) 571-0877
Credit cards accepted. 90 days same as cash.

CALIFORNIA

Enterprise Optics

Quality Custom Optics Since 1979

Newtonian and Cassegrain Optics 6" to 24"
1992 Complete Optics Catalog, Send $1.00 U.S.
$2.00 Canada or Foreign, in U.S. Currency.
P.O. Box 413, Dept. A • Placentia, CA 92670 USA
(714) 524-7520

CONNECTICUT

WHOLESALE OPTICS (PAULI'S)

57 North Street • Suite 401-401A (4th Fl.)
Danbury, CT 06810 USA
Distributors / Jobbers / Wholesale / Import / Export
∗ PUBLIC WELCOMED ∗ See our ad page 73.
Telescopes / Binoculars / Accessories
Tel. (203) 746-3579 / 792-0218 • FAX 746-7572

GEORGIA

Celestron - Meade - JMI
New - Used - Demos - Closeouts
COKE'S CAMERA CENTER
Ask for Bob or Jim
735 Cherry St., Macon, GA 31213
1-800-768-2653 9:00 am - 5:30 pm

NEW HAMPSHIRE

(WE BUY USED TELESCOPES)
Large in-store display. Celestron,
Meade, accessories. *Since 1930*

RIVERS CAMERA SHOP
454 Central Ave. • Dover, NH 03820
(603) 742-4888 • FAX (603) 742-5456
Hours: 8:30-6:00 Mon.-Thurs. • 8:30-8 Fri. • 8:30-5:30 Sat.

FLORIDA

SARASOTA CAMERA EXCHANGE & VIDEO CENTER

Celestron • Meade • Vixen
Telescopes and Microscopes

•B & L • Bushnell• Celestron • Leica
Meade • Minolta • Nikon • Pentax • Steiner
Binoculars
Dedicated astronomer on staff.

39 years experience
Call or write Chuck:
1055 South Tamiami Trail
Sarasota, Florida 34236
(813) 366-7484

NEW YORK

BERGER BROS.
CAMERA EXCHANGE

TELESCOPES
BINOCULARS
CAMERAS
CAMCORDERS

Over 45 years in business.
Honest Reputation.

BERGER BROTHERS CAMERA
209 Broadway • Amityville, NY 11701
Information: (516) 264-4160
Orders: 800-262-4160
Fax: (516) 264-1007

---

focus camera ENJOY ASTRONOMY AT DOWN TO EARTH PRICES

THE EAST COAST'S ONLY AUTHORIZED MEADE APD MAIL ORDER DEALER.

New York's Premier Store for the Astronomer! Our expert sales & support staff are just a phone call away. Whether you are a beginner or advanced astronomer, Focus Camera has the right telescope, binocular, camera or accessory for you. Choose from the finest equipment by Meade, Celestron, Bushnell, Nikon, Fujinon, Jim's Mobile, Thousand Oaks, Zeiss, Leica, Minolta and much more...

INFORMATION HOTLINE: (718) 436-6262
TOLL FREE ORDER LINE: 800–221–0828
24-HOUR FAX LINE: (718) 436-1518

4419-21 13th Avenue, Brooklyn, NY 11219
We ship nationwide - See our ad pages 102, 103.

OREGON

NURNBERG SCIENTIFIC
6310 S.W. Virginia Ave.
Portland, Oregon 97201

Call Stan, our astronomy enthusiast for expert, personal assistance in choosing a fine Meade or Celestron telescope.

(503) 246-8297
Hours: Monday - Friday 8:30 to 4:30

PENNSYLVANIA

OPTICAL GUIDANCE SYSTEMS
Custom-Made Ritchey - Chretien,
Classical Cassegrain and
Newtonian telescopes 10-32 inches.
2450 Huntingdon Place
Huntingdon Valley, PA 19006
(215) 947-5571

AMATEUR ASTRONOMERS!

Your one-stop "astronomy only" showroom and mail order store. Special sale prices on all World Famous Tele Vue Eyepieces, Accessories and the latest model Genesis 102mm Refractor. **NEW for 1992 - Tele Vue's 22 mm and 35 mm Panoptic Eyepieces - contact us for details.**

Recession Fighting Prices On

Celestron • Meade • Questar • Parks • Brandon • Edmund
University Optics • JMI • Thousand Oaks Solar Filters
B&L • Vogel • D&G • Kowa • Zeiss • Swarovski • Swift
Fujinon • Lumicon • Spectra • Beattie Screens
Bogen Tripods • and more!

All charts and publications. Send SASE for free price list
$4.00 for complete catalog package

✹ We ship everywhere ✹

SEE OUR AD ON PAGE 95.

NEW Tele Vue Pronto 70mm now in stock!

Wholesale Optics of Pennsylvania

RR 6 Box 6329, North Pocono Village Shopping Ctr.
Moscow, PA 18444 • (717) 842-1500 (9am-9pm)
Fax (717) 842-1408 (24 hrs.)
Showroom hours: 10-6 Mon – Saturday

WISCONSIN

EAGLE OPTICS

Binoculars, Telescopes, Star Charts, Accessories

Meade • Celestron • Tele Vue
Questar • Fujinon • Bausch & Lomb
Zeiss • Leica • Swarovski

6109 Odana Road • Madison, WI 53719
(608) 271-2444

ASTRONOMY *Blue Sky Pages*

Your guide to local astronomical dealers

CANADA, TORONTO

Telescopes, Binoculars, Books

"Exclusive Mail Order Source for Meade Advanced Products in Canada."

- Expert Advice
- Low Prices
- Canada Wide Delivery

SEND $3.00 FOR MAIL ORDER CATALOG
ALL MAJOR BRANDS

KHAN SCOPE CENTRE

3243 Dufferin Street • Toronto, Ontario, M6A 2T2
(416) 783-4140

CANADA, MANITOBA

COSMIC CONNECTION
32 Ashgrove Blvd. • Brandon, Manitoba
R7B 1C2 • (204) 727-3111
Telescopes & Binoculars
Celestron, Lumicon, Thousand Oaks and More!
Canada-Wide Mail Order Service
– Our $4.00 Catalog is full of low prices –

GREAT BRITAIN

Broadhurst Clarkson & Fuller Ltd.
63 Farringdon Road • London EC1M 3JB
TEL. +44 405 2156 • FAX +44 71-430 2471

Celestron, Meade, Tele Vue, Vixen, JMI, Losmandy, Lumicon

IT'S EASY TO ADVERTISE IN THE BLUE SKY PAGES.

For information on advertising in the Blue Sky Pages, call Cathy Odland or Greg Swan at (800) 558-1544

TEXAS NAUTICAL REPAIR CO.

TEXAS

Importer and Distributor of TAKAHASHI Telescopes and Miyauchi binoculars.

TEXAS NAUTICAL REPAIR CO.

3110 S. SHEPARD
HOUSTON, TX 77098
1-800-880-3551 FOR ORDERS ONLY
713-529-3551 (technical info & assistance)
FAX 713-529-3108

CALIFORNIA

Spectra™ Astro • Systems

We KNOW Takahashi because we USE Takahashi.

Astronomical quality at down-to-earth prices!
1-800-735-1352 • FAX 818-996-7698
Hrs. 9 – 5 M-F (Pacific time)
6631 Wilbur Ave, Suite 30 • Reseda, CA 91335

MASSACHUSETTS

Sales and Service of Telescopes and Binoculars FOR 75 YEARS!

F.C. Meichsner Co.
182 Lincoln St. • Boston, MA 02111
1-800-321-VIEW • FAX 617-542-7809
Business hours 9-6 T-F, Sat. 10-4, Sun. 12-5

COLORADO

Your full-service source for astronomical equipment and accessories.
Ask for Cathie, our Takahashi specialist.

S & S OPTIKA
5174 S. Broadway • Englewood, CO 80110
303-789-1089 Tues. – Fri. 10-6, Sat. 10 – 4

ONTARIO, CANADA

Perceptor
TelescopesTransCanada
Brownsville Junction Plaza
Box 38, Suite 201
Schomberg, Ontario L0G 1T0

(416) 939-2313
Toll-free from Metro Toronto

ALL MAJOR BRANDS

friendly service – expert advice – low prices
showroom north of Toronto – shipments across Canada

READER'S EXCHANGE

FOR SALE — Send a business-sized SASE for three tests that will prove or disprove the Theory of Relativity. Contact Nicholas Schneiders, 10603 S. Wilcrest Dr. #39, Houston, TX 77099.

FOR SALE — Parks mirror and diagonal, 8″ f/6. Best offer or trade for 8″ or 10″ Odyssey, 80mm binoculars, or what you want to trade. Contact Todd Cardona, 8689-2 N. Ridge Ave., Berrien Springs, MI 49103.

FOR SALE — Solar projector, 12″ long, mounts on camera tripod. $170. Contact Ed Jones, 610 Woodland Dr., Cincinnati, OH 45244. Phone (513) 248-2883.

READER'S EXCHANGE

FOR SALE — Meade DS-10A reflector with dual-axis drive corrector. Equatorial mount, accessory shelf, leveling screws/casters. 8x50 finder and 2″ photo guide scope. Orion 2x Barlow and moon filter. 12/25 MA eyepieces and 7mm Ortho for 1.25″. $850. Contact Rich Levenson, 14 Sandpiper Dr., Manalapan, NJ 07726. Phone (908) 446-7945.

FOR SALE — Digital sidereal clock with alarm. Includes instructions for setting local sidereal time. $79. Contact Jose Valdes, 10123 Boynton Place Cir., Boynton Beach, FL 33437. Phone (407) 736-9029 evenings.

READER'S EXCHANGE

FOR SALE — Positions as players in Rule the Universe, a strategic futuristic wargame in space. Travel over 2000 stars while controlling military, social and economic directives. Compete worldwide by mail. Send $1.00 for information. Contact G.F. Carbone, P.O. Box 8051, Wichita, KS 67208-0051.

WANTED — Thirty-seven-year-old amateur astronomer would like to correspond worldwide with astronomers and philatelists interested in putting together a collection of the history of astronomy and exchange stamps. Contact Istvan Farago, Kismartoni utca 87, H-2040, Budaors, HUNGARY.

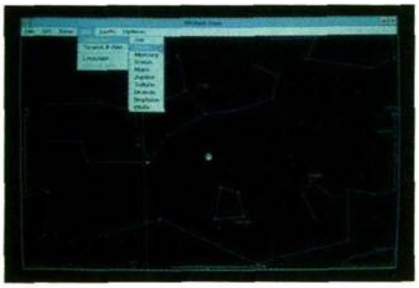
DISTANT SUNS FOR WINDOWS

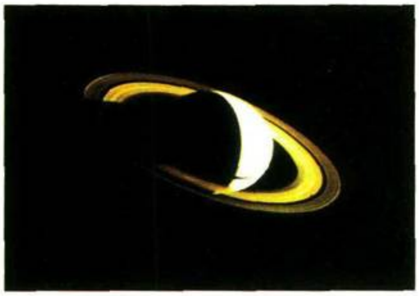
***Distant Suns™ Windows™**, Virtual Reality Laboratories, Inc., 2341 Ganador Court, San Luis Obispo, CA 93401. $129.95. Minimum requirements: 80286 or higher processor, MicroSoft Windows 3.X, EGA or higher, and 5.3 MB of available storage space on a hard disk. 1.2 MB $5^{1}/_{4}$" diskettes are included, but a swap coupon for $3^{1}/_{2}$" diskettes is enclosed.*

Distant Suns is a basic planetarium-type program that displays the positions of stars, planets, and deep-sky objects. You can move around the sky quite easily and, since it is Windows-based, all the features of the program — such as turning on constellation names — are just a click of the mouse away. A window containing information appears when you click on most objects. With the Messier objects, the information window includes a small image. The database includes 9,100 stars and 450 galaxies, nebulae, and star clusters, and you can add up to 3,000 other objects of your choice. You can print out sky maps with special deep-sky object symbols and view lunar phases, solar eclipses, and the positions of the planets in their orbits. The times and locations of eclipses are only approximate though; for accurate times you should use a program written explicitly for eclipse predictions.

Accessing the program's images (scanned photographs) of the planets and several deep-sky objects couldn't be simpler. For example, to retrieve images of the Moon, use the Quickaim feature to find and center the Moon on the screen, then click the right mouse button twice to view a series of lunar images.

You need to set Windows to 256-color mode to view the images properly. A quick check of the easy-to-read manual tells you about this, but perhaps these instructions could be included in the Quickstart guide. After readjusting Windows, I couldn't have asked for better images — not quite photo quality, but good for a computer monitor. My only regret was that there weren't more of them on my disk. But never fear, die-hard image fans — more images are available at a reasonable price from Virtual Reality. And you can add your own images after conversion to the Windows image format (".BMP").





I have only minor suggestions for improving this program. The location list could include some of the major observatories. While they can be added by the user, it would be helpful if the designers provided them with the program. It would also be nice if we could view lunar eclipses. The manual is well written and includes examples of events that may be viewed with Distant Suns. But the examples might be easier to find if they were set off somehow from the other text material.

Distant Suns is a good planetarium program for its price and fun to use. While not as powerful as some of its more expensive cousins, it stands out for the beautiful images it provides of the Moon and planets. — *Dave Bruning*

Database of Astronomy Software

John DiElsi, director of academic computing at Mercy College, has produced a database of astronomical software for microcomputers. The database includes information on over 300 programs for IBM-compatible, Macintosh, Apple, Atari, Amiga, and Commodore computers from more than 100 vendors. You can obtain a free disk copy of this information by sending a blank disk in a stamped, self-addressed disk mailer to John DiElsi, Director of Academic Computing, Mercy College, 555 Broadway, Dobbs Ferry, NY 10522. Specify if you want information on all available programs or a

Astronomy software for the
Macintosh
FULL COLOR ANIMATED GRAPHICS

- Jupiter and satellites
- Saturn, rings, and satellites
- Solar System: orbits of 9 planets and 260 asteroids
- Julian Day, Universal Time, and Sidereal Time clock displays
- Full-screen calendar display of any month from 4713 BC to 9999 AD, Gregorian or Julian

FOR FREE CATALOG & PRICES, WRITE:
Jim Fremont
6646 Alcove Ave.
North Hollywood, CA 91606-1109
or call 1-818-760-8178

Mediterranean
Star Gazing
June 6-13, 1992
STAR CLIPPER
Dr. Donald Drost, Astronomer
Guest Lecturer
from **$1095** per person

Call for more info on our
upcoming college tour.

Exclusive Travel Designs
Dallas, Texas
800-421-2945

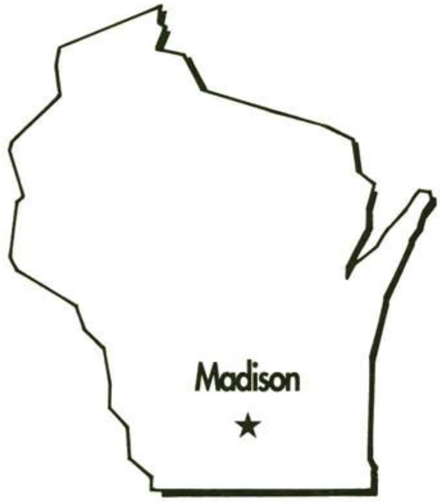
VISTA
PROGRAMMABLE
TELESCOPE DRIVES

Single or dual axis. 6000 selections. 56-83 Hz setable. Inputs / outputs, 120 Vac and / or 12 Vdc. **$335 - $375.** *Other drives available too.*
(Prices subject to change)
Send check or money order to **Box 1919, Santa Maria, CA 93456.**
Or order by phone with MasterCard or Visa:
1-800-552-9170
California residents add state sales tax. Call for rates on shipping, handling and insurance. For free brochure, call **(805) 925-1240.**
VISTA INSTRUMENT CO.

CHASE THE MOON'S SHADOW
JUNE 30, 1992

MEET US IN RIO
FLY TO THE ECLIPSE
FOR
ONLY $750.

Write to Amateur Astronomers Inc., Union College, Cranford, NJ 07016 for information on this breathtaking adventure.
or Call Roger Tuthill (800) 223-1063



Ordinarily it's the center of Wisconsin.
This summer, it'll be the center of the universe.

Universe 92 – A Weekend Astronomy Expo
June 20 and 21, 1992 — University of Wisconsin - Madison
Open to all with an interest in astronomy
Presented by the Astronomical Society of the Pacific and **ASTRONOMY** magazine

Featuring:

- **The midwest's largest product fair** with displays of telescopes, accessories and software from major manufacturers.
- **Nontechnical talks by astronomers** on new developments in astronomy, including the Hubble Space telescope, the exploration of the planets, and the latest about black holes.
- **Introductory talks** on getting started in astronomy.
- **Seminars and workshops** for amateurs.

plus. . .

Conference events June 22-25

- **Tours** of the Yerkes Observatory.
- **Workshop on teaching** astronomy in grades 3-12 (with credit).
- **Scientific meeting** on massive stars.

UNIVERSE 92

For more information and a registration packet write:
Wisconsin Meeting Information
A.S.P.
390 Ashton Ave.
San Francisco, CA 94112
or call (415) 337-1100

SpaceTime!
ALARM CHRONO
CASIO
10:58 50
MON 6-30
WATER RESIST

Cosmo Phase Watch–$43.99 +$5 shipping in U.S.

- Hour, minute, second, am/pm, year, month, date, day.
- Pre-programmed until the year 2200.
- 12/24-hour formats.
- Simulation of revolution of planets.
- Solar system, Halley's comet, and solar eclipse data.
- Multi-function alarm.
- Hourly time signals.
- 1/100 sec. stopwatch.
- Countdown alarm.
- Accuracy of ±15 seconds per month.
- Battery life approximately 3 years.

OUR 75TH YEAR!

F.C. Meichsner Co. Inc. 182 Lincoln St., Boston, MA 02111
Phone: **1-800-3-2-1-View!** (1-800-321-8439)
F.C. Meichsner Co. is a full service telescope and binocular store. Call or write for astronomical equipment price lists. Visa, MasterCard, American Express, Discover, money orders and personal checks accepted. Mail-orders and orders by phone accepted. Add $5 per order for shipping within the U.S. Add $8.50 per order for shipping outside the U.S.

listing of those for just one computer system. Also indicate on which type of computer you will read the disk.

NEW PRODUCTS

***IMAGINE-32**, CompuScope, 3463 State Street, Suite 431, Santa Barbara, CA 93105. Phone (805) 687-1914. $299 (demo is available). Minimum requirements: 80386SX-based computer or higher, 2 MB memory, 5 MB available space on hard disk, math coprocessor, VGA or higher; mouse recommended.*

This image-processing program uses the full ability of 32-bit 80386- and 80486-based computers to display and manipulate images. Users can analyze large-format images (1024 x 1024 and beyond) and the image drivers are optimized so 800 x 800 images are displayed in only two seconds. Up to fifteen images can be displayed simultaneously for comparison. A Windows-like environment makes this software easy to use.

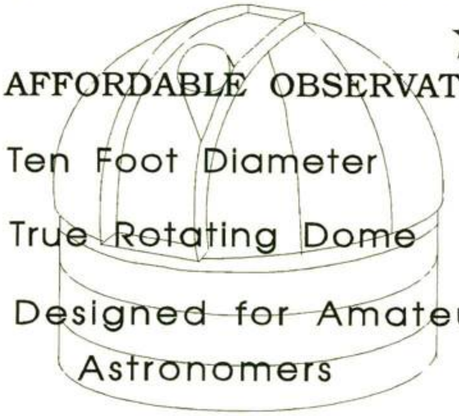
***Voyage to the Stars and Voyage to the Planets,** Astronomical Research Network, 206 Bellwood Avenue, Maplewood, MN 55117. Phone (612) 488-5178. $149.95 for each CD-ROM disk in series. For IBM PC-compatible or Mac II computers. PC minimum requirements: 640 KB memory, CD-ROM player, DOS 3.2 or higher, VGA or higher; hard disk recommended. Mac II minimum requirements: 2 MB memory, CD-ROM player, System 7 compatible; hard disk recommended.*

Voyage to the Stars is a five-volume set of CD-ROMs (each CD-ROM is sold separately). Volumes 1, 2, and 3 are now available and contain, respectively, images and descriptions of galaxies, objects photographed by David Malin of the Anglo-Australian Observatory, and objects recorded by the IRAS infrared satellite. A future CD-ROM will contain Hubble Space Telescope images.

Four volumes are available in the Voyage to the Planets series. Like the Stars series, these CD-ROMs contain images and descriptions. Volume 1 covers Jupiter, Saturn, and Uranus. The remaining three volumes cover one planet each — Neptune, Mars, and Venus. Future volumes are planned for Mercury and Pluto, and for Earth and the Moon. □

INTRODUCING

☆ HOME-DOME™ ☆



The AFFORDABLE OBSERVATORY

- * Ten Foot Diameter
- * True Rotating Dome
- * Designed for Amateur Astronomers

Introductory Offer...

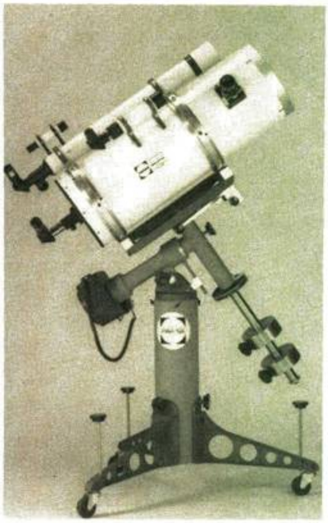
- * Complete Dome System
- * Dome/Shutters/Base Ring
- * $3000

Technical Innovations
22500 Old 100 Road
Barnesville, Md. 20838
301-972-8040

Call or Write for FREE Brochure

FORT DAVIS ASTRONOMICAL SUPPLY

Featuring Parks Optical Telescopes and Accessories



- Quality binoculars; 8x21 thru 25x100.
- Full line of refractors and Newtonian reflectors in stock.
- New H.I.T. series f/3.5 Newtonian - f/15 Cassegrain.
- Finest new Gold – Series Plössl eyepieces in stock; 3.8 mm to 35 mm. Outstanding performance.
- 2" Kellner, Plössl and Erfle eyepieces.
- Photo/Visual filters of all types including Lumicon, UHC and O III.
- JMI Motofocus and new ball-bearing 2" focusers.
- High quality, multi-coated spotting scopes.
- ATM components and supplies in stock or readily available.

ALSO AT PRUDE RANCH – SITE OF THE TEXAS STAR PARTY

Main Street, Fort Davis
P.O. Box 922 • Fort Davis, TX 79734
Phone: 915/426-3008 • FAX: 915/426-3023

PRECISION SOLAR FILTERS

Thousand Oaks Optical solar filters are recognized around the world for their quality, consistent density and even coating across the entire aperture. We specialize in solar filters only and are the largest solar filter manufacturer in the world. Filters are available to fit all brands of telescopes and binoculars. **Thousands of our filters are in use around the world. The preferred choice of telescope dealers and exclusively used by NASA aboard the Space Shuttle.**

TYPE 1 - Made from high quality hand select glass, machine polished and **TRIPLE COATED** with a Nickel-Chromium alloy (same as Inconel). Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

TYPE 2 - Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

TYPE 3 - Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 and 2. Type 3 filters are for photographic use only.

Type 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

Our filters are many times more durable than common aluminized Mylar. Aluminized plastic cannot hold up to long term ultraviolet radiation and environmental contaminants as well as Nickel-chrome and stainless steel coated glass. Wrinkled Mylar can cause visual and photographic difficulties, can be easily damaged in handling or if placed on an uneven surface, and is difficult to clean. Also, a light blue solar image does not yield as much detail and contrast.

GLASS (Full Aperture) Type 1

Aperture	mounted:	Aperture	unmounted:
2.4"	$ 44.00	2.4"	$ 34.00
3.1"	48.00	3.1"	38.00
3.5" to 4"	54.00	3.5" to 4"	44.00
5"	69.00	5"	59.00
6"	74.00	6"	62.00
8"	89.00	8"	76.00
10"	99.00	10"	89.00
11"	109.00	11"	99.00
12.5" to 13.1"	129.00	12.5" to 13.1"	109.00
14"	149.00	14"	129.00
40mm to 80mm Binoculars			$ 85.00 pr.

GLASS (Full Aperture) Type 2

Aperture	mounted:	Aperture	unmounted:
2.4"	$ 59.00	2.4"	$ 45.00
3.1"	62.00	3.1"	49.00
3.5" to 4"	72.00	3.5" to 4"	55.00
5"	92.00	5"	75.00
6"	99.00	6"	85.00
8"	119.00	8"	99.00
10"	129.00	10"	115.00
11"	149.00	11"	129.00
12.5" to 13.1"	169.00	12.5" to 13.1"	149.00
14"	189.00	14"	169.00
40mm to 80mm Binoculars			$109.00 pr.

GLASS (Full Aperture) Type 3

Aperture	mounted:	Aperture	unmounted:
2.4"	$ 77.00	2.4"	$ 59.00
3.1"	80.00	3.1"	62.00
3.5" to 4"	94.00	3.5" to 4"	72.00
5"	119.00	5"	90.00
6"	129.00	6"	110.00
8"	154.00	8"	129.00
10"	168.00	10"	149.00
11"	193.00	11"	168.00
12.5" to 13.1"	219.00	12.5" to 13.1"	193.00
14"	245.00	14"	219.00

THREADED CAMERA FILTERS

All standard sizes available from 46mm to 82mm in Type 2 or Type 3. Please call or write for additional information.

ORDERING INFORMATION: Solar filters are shipped free in continental U.S. when payment is included with order. Shipping extra on credit card orders ($3 - $6 depending on aperture). Payment may be made by personal check, bank check or money order. We also accept **Visa, Mastercard** and **American Express. PLEASE SPECIFY TELESCOPE BRAND AND/OR OUTSIDE DIAMETER MEASUREMENT OF TELESCOPE TUBE.** The cost of the filter is based on the telescope aperture. The mounting cell fits over and around the end of the telescope tube. The coating faces the inside. Unmounted filters are the glass only.

Free brochure available. Foreign inquiries: Please include $1 for return airmail postage of brochure. Proforma invoices available upon request.

30 DAY UNCONDITIONAL MONEY-BACK GUARANTEE

SOLAR ECLIPSE VIEWERS

Mylar

Aluminized on both sides. Mounted in rigid frame. Mylar window: 1 5/8" x 3 1/8". Each filter supplied in individual envelope. Light transmission is blue. Designed for naked eye visual use.

3" x 5" Overall size .... $1.00 ea.

Plastic

Same as Mylar except this filter yields a sharper image with orange transmission.

2 5/8" x 4 5/8" Overall size .... $2.00 ea.

Minimum order of 10 eclipse filters in any combination. Please add appropriate shipping/handling. 10 units: $3.00. Plus $1.00 for each additional 10 units. Minimum credit card order of $25.00. Quantity discounts available starting at 100.

Mylar and plastic viewers are coated to a neutral density of 5. Transmission in visual light is approximately 1/1,000th of one percent. There is no significant transmission in ultraviolet or infrared.

THOUSAND OAKS OPTICAL
Box 248098 Dept. A
Farmington, Michigan 48332-8098
Phone: (313) 353-6825 Fax: (313) 350-3111

focus camera, inc.

The East Coast's Only Authorized Meade APD Mail-Order Dealer

ENJOY ASTRONOMY AT DOWN TO EARTH PRICES

Since 1964 we have been serving customers nationwide with all their Photographic & Astronomical needs. Join our thousands of satisfied customers today and save.

FOR ORDERS ONLY CALL **800 221-0828**

INFORMATION HOTLINE **(718) 436-6262**

Meade Advanced Products

LX100 and LX200 SCHMIDT-CASSEGRAINS

YOUR CHOICE F/6.3 OR F/10 SCT OPTICS

Available in 8" 1200mm F/6.3, 8" 2000mm F/10, 10" 1600mm F/6.3 or 10" 2500mm F/10 configurations the new LX100 and LX200 Schmidt-Cassegrains advance the state-of-the-art.

LX100 SERIES

Meade optical tube assembly with SMC super multicoatings, heavy duty fork arm equatorial. Smart Drive PPEC RA motor drive with ECC hand controller for drive correction at 2x speed and image centering at a fast 32x speed.

Factory Package Includes;
F/6.3 or F/10 optical tube, ECC, 6x30 (8") or 8x50 (10") finder, 26mm eyepiece, 1¼" diagonal, AC adapter, DC car-cord, AA battery pack, field tripod, wedge (8"), Superwedge (10") and foam fitted carrying case.

LX100 8" $1695 LX100 10" .. $2395

LX200 SERIES

The new LX200 series offers, for the very first time, an easy to use, affordable, fully computerized slewing telescope. For "painless" observation simply align the telescope (using the LX200 computer) and enter any of the 747 objects contained in its built-in library and the LX200's PPEC Smart Drive will automatically slew to that object at an incredible 8° per second. To take great astronomical photos just add the optional equatorial wedge for accurate polar axis tracking.

LX200 8" $1995 LX200 10" .. $2295

Wedge (8") .... **110** Superwedge (10") **395**

Additional Object Library - adds 8000 CNGC objects to the LX200's built-in computer library **99**

PREMIER SERIES

· FREE ACCESSORIES · FREE ACCESSORIES ·

Purchase any Premier Smart Drive telescope from Focus Camera before March 31, 1992 and receive an exclusive Meade accessory package from Focus Camera.

PREMIER 2080/50SD

THE PREMIER SCHMIDT-CASSEGRAIN TELESCOPE FOR ASTROPHOTOGRAPHY

8 inch 2000mm F/10 diffraction limited optics with Meade's exclusive SMC super multi-coatings PPEC computerized permanent Periodic Error Correction Smart Drive motor drive system which operates from AC, DC or AA batteries and offers the ultimate in tracking accuracy.

$1799

FACTORY PACKAGE INCLUDES:
Optical tube, Smart Drive, 26mm & 12.4 mm Super Plossl eyepieces, 9x60 RA polar illuminated finder, 2/1¼" diagonal, ECC hand controller, field tripod, equatorial wedge, AC adapter, AA battery pack, case

List Price Over $2900, **Limited Supply**

PREMIER SERIES *All Complete Factory Packs*	**2080** *8 Inch*	**2120** *10 Inch*
40 SD F/10 **Smart Drive**	**1479**	**1999**
46 SD F/6.3 **Smart Drive**	**1639**	**2109**
56 F/6.3 ***SPECIAL***	**1699**	**2139**
50 SD F/10 **Smart Drive**	**1799**	**2299**
56 SD F/6.3 **Smart Drive**	**1939**	**2399**
70 SD F/10 **Smart Drive**	**3219**	**4079**
76 F/6..3 **SPECIAL CLOSEOUT**	--	**3699**
76 SD F/6.3 **Smart Drive**	**3409**	**4179**

Super Wedge option for 2120 Premiers **259.95**

STANDARD SERIES SCHMIDT-CASSEGRAINS

2045D *"The truly portable scope"* ...... **SPECIAL**
4 inch 1000mm F/10 optical tube with SMC multicoatings, equatorial fork mount with reversible DC motor drive & table tripod, 5x24 finder, 1¼" diagonal, 25mm eyepiece and AA battery pack.

Case for 2045D .... **68.95** Tripod & Wedge **235**

2080A *"Perfect for the beginner"* .... **SPECIAL**
8 inch 2032mm F/10 Schmidt Cassegrain optics equatorial fork mount with motor drive, **wedge, tripod,** 6x30 finder, 1¼" diagonal,25mm eyepiece.

2080B with SMC multicoatings .... **CALL**

2120A *"The best value 10" SCT"* **$1495**
10 inch 2500mm F/10 Schmidt Cassegrain optics equatorial fork mount with motor drive, **wedge, tripod,** 6x30 finder, 1¼" diagonal,25mm eyepiece.

2120B with SMC multicoatings .... **CALL**

STARFINDER NEWTONIANS

The new Starfinder telescopes represent the best value in Newtonians available today.

Each Starfinder telescope features Meade's hand figured optics, a precision equatorial mount with integrated motor drive, setting circles & stand.

All include #71 rack-and-pinion focuser, 6x30 finderscope and 25mm eyepiece

STARFINDER 6	6 Inch F/8	**499.95**
STARFINDER 8	8 Inch F/6	**599.95**
STARFINDER 10	10 Inch F/4.5	**699.95**
STARFINDER 16	16 Inch F/4.5	**CALL**

Includes heavy duty sealmaster bearing mount and combination 1¼/2 inch rack-and pinion focuser

STARFINDER ACCESSORIES

Dust cover for Starfinder 6/8/10 .... **29.95**

#55 Manual Declination Control **79.95**

#43 Drive Corrector - powers scope from 12v DC & provides RA drive correction for photography **84.95**

#47M Dual-Axis Drive Corrector - similar to #43 but includes DEC motor & hand controller **299.95**

4420 NEWTONIAN

#1 Top Rated by Astronomy

The Meade 4420 is the perfect telescope for the beginner. Its large 4½ inch aperture optical tube & equatorial mounting make it ideal for planetary, deeper space observation or astrophotography. a 1¼ inch rack-and-pinion focuser, 5x24 finderscope and 25mm (36x) eyepiece and full height tripod are included.

SPECIAL PRICE

DS-10A NEWTONIAN

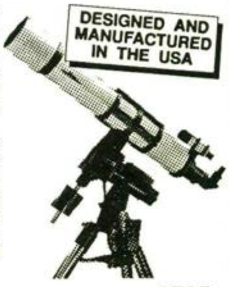
The perfect telescope for deep space observation & photography. This 10 inch 1150mm F/4.5 Newtonian features American made hand figured optics, a rugged equatorial pier mount & stand with motor drive and includes combination 1¼/2" rack-and-pinion focuser, 25mm eyepiece & setting circles **$639**

VERY LIMITED SUPPLY

826C 8 Inch F/6 Newtonian **$799**
This top-rated Meade Newtonian includes pier mounted deluxe equatorial mount with motor drive, rack-and-pinion focuser, 25mm eyepiece and 8x50 finderscope.

ED APOCHROMATIC REFRACTORS

DESIGNED AND MANUFACTURED IN THE USA



Meade's new American made ED Apochromatic equatorial refractors feature a F/9 doublet design with an Extra-low Dispersion rear element for the ultimate in optical performance.

Each of these fine instruments is matched to a Meade LXD 600 or 700 equatorial mount & metal field tripod. This brand new design features massive polar & dec. castings, eight ball bearings, and ultra-precise worm drives.

102ED 4 Inch F/9 .... **1795**
Includes; Optical tube, 2.7" focuser, 2" diagonal, 8x50 finderscope 26mm New Super Plossl eyepiece, LXD600 equatorial mount, heavy duty metal tripod

127ED 5 Inch F/9 .... **CALL**

152ED 6 Inch F/9 .... **CALL**
Same as 102ED but with LXD 700 mount

178ED 7 Inch F/9 .... **CALL**
Same as 102ED but with LXD 700 mount

#1664 Electronic Drive System **295**
Microprocessor controlled dual-axis drive system featuring Meade Smart Drive programmable periodic error correction for accurate tracking

#1697 Computer Drive System **595**
Computerized Smart Drive drive system for the new LXD 600 & 700 mounts features computerized slewing, digital readouts, automated polar alignment, GOTO funtion to automatically position scope, 747 object library.

Additional Object Library - adds 8000 CNGC objects to the LX200's built-in computer library **99**

EYEPIECES & ACCESSORIES

Meade Series 4000

SUPER PLOSSL - Up to 52° Apparent Field
6. 4, 9.7, 12.4, 15, 20, 26mm 1¼" **63.95**
32mm 1¼" .... **83.50** 40mm (44°AF) **87.50**
56mm 2 inch **158.50**
2X Barlow 1¼" #140 .... **61.95**

SUPER WIDE ANGLE - 65° Apparent Field
13.8mm 1¼" ...... **105.95** 18mm 1¼" **113.95**
24.5mm 1¼" ...... **118.95** 32mm 2" **178.50**
40mm 2 inch **253.50**

ULTRA WIDE ANGLE - 84° Apparent Field
4.7mm 1¼" .... **118.95** 6.7mm 1¼" **143.95**
8.8mm 1¼/2" .... **159.95** 14mm 1¼/2" **199.50**

NEW STYLE SERIES 4000 EYEPIECES .... CALL

#712 Dew Shield 8" (2080)	**89.95**
#710 Dew Shield 10" (2120)	**117.95**
ECC Hand Controller (Premier 2120/30)	**219.95**
#39 DEC Motor (LX5, Premier 30/36/40/46)	**88.95**
#1200A Focus Motor (LX5, Premier)	**189.95**
#9068/#9070 Digital Readout	**269.95**
#9008/#9010 CAT Computer Aided Telescope for Premier & LX6 scopes	**799.95**
CAT-COM RS-232 interface	add'tl **149.95**
#62 Schmidt Cassegrain Camera Adapter	**24.95**
Basic Camera Adapter .96" (Refractor)	**24.95**
Basic Camera Adapter 1¼" (Refractor)	**29.95**
Variable Projection Camera Adapter 1¼"	**39.95**
#106 Off-Axis Guider System (2080/2120)	**153.95**
Telecompressor System f/above	**56.95**
Wide-Field Adapter System (2080/2120)	**107.95**
#928 45° Erect Image Diagonal	**49.95**
# 929 2" Giant Diagonal (w/1¼" adapter)	**89.95**

	Broadband	Narrowband
#908 Nebular Filter	**67.95**	**89.95**
#910 Nebular Filter	**99.95**	**119.95**
#911 Nebular Filter	**87.95**	**109.95**

Meade

MULTICOATED OPTICS LIFETIME WARRANTY

Spotting Scopes

97E WITH CASE

- 3½"1000mm F/11 optics
- 5x21 erecting image finder
- 45° erecting diagonal
- 40x Meade eyepiece

$334

97ER Rubber Armored	**369**
Eyepieces (111x, 80x, 55x, 25x)	**37.95**
Camera Adapter .. **34.95** Hard Case	**44.95**
Hybrid Diagonal allows use of 1¼ eyepieces	**48**
2045S 4" SPOTTING SCOPE	**429**

The 2045S uses Meade's astronomical grade 4" 1000mm F/10 Schmidt-Cassegrain optics. It features SMC multi-coatings and micrometer focus plus a 25mm (40x) 1¼" eyepiece, erect image diagonal & 5x21 finderscope.

MEADE REFRACTORS

290 60mm Equatorial Refractor	**209.95**
312 3.1" 900mm Alt-Azimuth Refractor	**379.95**
323 3.1" 900mm Equatorial Refractor	**424.95**

ASTRONOMICAL BINOCULARS

Meade

11x80 NEW Multicoated & Rubberized w/BAK 4 prisms, tripod adapt & case	**359.95**
20x80 NEW Multicoated & Rubberized w/BAK 4 prisms, tripod adapt & case	**379.95**

CELESTRON

HOW TO CHOOSE BINOCULARS	**12.95**

This book by Alan Hale is the most comprehensive guide to binoculars ever published. Quickly & easily shows you how to select the best pair of binoculars for your purpose.

7x42 Ultima Seies	**179.95**
8x56 Ultima Series	**189.95**
10x50 Ultima Series	**199.95**
11x80 Multicoated w/case & tripod adapt.	**309**
15x80 Multicoated **NEW**	**319**
20x80 Multicoated w/case & tripod adapt.	**324**

FUJINON BINOCULARS

The Fujinon SX & F-SX series binoculars are probably the finest binoculars available today for astronomical and general observation. They are built to full military specification 100% waterproof, multi-coated and offer an unprecedented 95% light transmission. The F-SX series binoculars also offer an exceptionally long eye relief of 23mm making them ideal for glasses wearers.

6x30 FMTR-SX Rubber Armored **NEW**	**374.95**
7x50 MT-SX w/carry case	**324.95**
7x50 MTR-SX Rubber Armored	**349.95**
7x50 MTRC-SX Armored w/compass	**409.95**
10x70 MT-SX w/carry case	**404.95**
14x70 MT-SX w/carry case	**424.95**
7x50 FMT-SX w/carry case	**378.95**
7x50 FMTR-SX Rubber Armored	**427.95**
7x50 FMTRC-SX armored w/compass	**497.95**
8x30 FMTR-SX Rubber Armored	**384.95**
10x70 FMT-SX w/carry case	**457.95**
16x70 FMT-SX w/carry case	**567.95**
Tripod Adapter	**14.95**

JMI - JIM'S MOBILE

Motodec DEC Motor	**74.50**
Motofocus Focus Motor (SCT)	**78.50**
NGC-MINI MAX Computer System	**569**
NGT-16/18/25 Telescopes	**CALL**

THOUSAND OAKS OPTICAL

The finest Solar Filters recognized the world over for their quality are now available at Focus Camera.
Call Today for our Great Prices

CELESTRON

SUPER POLARIS C8

The Celestron Super Polaris C8 has long been Europe's most popular Schmidt-Cassegrain telescope. These fine instruments combine Celestron's world renowned 8 inch 2032mm F/10 optics with the versatile Super Polaris equatorial mount. Focus Camera's special packages also include the RA motor drive system to provide RA tracking & drive correction.

FOCUS CAMERA EXCLUSIVE OUTFIT INCLUDES;

8 inch F/10 optical tube (multi-coatings on Starbright outfit), Super Polaris equatorial mount with illuminated polar axis finder, Celestron single axis drive, 5x24 finderscope (6x30 with Starbright outfit),**24mm Ultima eyepiece**, star diagonal,adjustable field tripod & case.

SUPER POLARIS C8
STANDARD PACKAGE **$997.95**

SUPER POLARIS C8
STARBRIGHT PACKAGE **$1187.95**

*** FREE ***
CELESTRON SINGLE AXIS MOTOR DRIVE WITH PURCHASE

CLASSIC 8 STARBRIGHT

The Classic is the latest in a long line of fine Schmidt-Cassegrain telescopes from the company that pioneered top quality commercial telescopes.
COMPLETE READY TO USE PACKAGE INCLUDES: 8 inch 2032mm F/10 optical tube with Celestron's exclusive **Starbright** coatings, rugged swing fork equatorial mount with precision spur gear drive, 25mm Kellner eyepiece, 6x30 finder, 1¼" star diagonal, wedge and **Rubberized Field Tripod** **$1187**

POWERSTAR PEC

The new Powerstar PEC features Celestron's famed 8 inch Schmidt Cassegrain optics with **Starbright** coatings, PEC periodic error correction DC servo drive system & Byers worm gear for improved tracking accuracy, 30mm Plossl eyepiece, 6x30 finderscope 1X" Star Diagonal, case, wedge & rubberized tripod **$1517**

ULTIMA 8 PEC

The state of the art 8 inch Schmidt Cassegrain telescope from Celestron. It features a rugged swing fork mount with carrying handles for ease of set up, a massive cast polar shaft with 4" ball bearings, 7½" Byer's worm gear drive & PEC periodic error correction drive system for the ultimate in drive accuracy. **$1845**
COMPLETE FACTORY PACKAGE INCLUDES: 8 inch 2032mm F/10 optical tube with **Starbright** coatings, PEC drive system with hand controller, 30mm Plossl & 7mm Ortho eyepieces, 8x50 Polar illuminated finderscope, 1¼" Star Diagonal, case, wedge & rubberized tripod

ULTIMA 11 PEC

The ultimate 11 inch Schmidt-Cassegrain telescope. The Ultima 11 includes 11" 2800mm F/10 optical tube with **Starbright** coatings, rugged swing fork equatorial mount with PEC motor system featuring a 7.54 Byers worm gear drive, hand controller, 8x50 finder, 2" star diagonal, 30mm & 18mm eyepieces, vibration suppressor pads, heavy duty wedge, rubberized field tripod and rugged fitted case. **CALL**

CELESTRON REFRACTORS

C60E 60mm F/13 Equatorial Refractor	**194.95**
Firstscope 80 3.1" Alt-Azimuth Refractor	**449.95**
Super Polaris C80	**608.95**
Super Polaris C102	**1039.95**

C4.5 NEWTONIAN

4½ inch 900mm F/7.9 Equatorial Newtonian with field tripod, 25mm 1¼" (36x) eyepiece, 5x24 finderscope **$399**

SUPER POLARIS C6

6 inch 750mm F/5 wide-field Equatorial Newtonian with Super Polaris mount, field tripod, 18mm (42x) eyepiece, 6x30 finderscope **$719**

CELESTRON ACCESSORIES

STEREO BINOCULAR VIEWER	**419.95**
AC adapter (PEC telescopes)	**26.95**
Counterweight Set 8"	**48.95**
DEC or Focus Motor (Classic/Ultima 8)	**98.95**
DEC or Focus Motor (PEC Scopes)	**94.95**
F/6.3 Focal Reducer/Correcter	**143.95**
Off-Axis Guiding System w/eyepiece	**139.95**
NEW Radial Guider	**118.95**
Micro Guide Eyepiece	**138.95**
NEW Multi-Function Focal Tester MMFT-55	**157.95**
Advanced Astromaster Computer	**552.95**
C4.5 Motor Drive	**164.95**
Dual Axis Motor Drive SP-C8/6/80/102	**254.95**
Polar Axis Finder SP-C8/6/80/102	**74.95**
Piggyback Mount SP-C6/80/102	**39.95**
Piggyback Mount all 8" scopes	**36.95**

CELESTRON EYEPIECES

ORTHOSCOPIC - Up to 45° Apparent Field

5, 6, 7, 9, 12mm .96"	**36.95**
5, 6, 7, 9, 12,mm 1¼"	**47.95**
2X Barlow 1¼"	**40.95**
2X Barlow 2"	**94.95**
ULTIMA SERIES EYEPIECES	
5, 7.5, 12.5, 18, 24mm 1¼"	**62.95**
30, 35, 42mm 1¼"	**88.95**
45, 60mm 2"	**166.95**
15, 19, 23mm 1¼" Wide-Angle	**112.95**
2X Barlow Ultima Series 1¼"	**63.95**

CELESTRON FILTERS

These fine Celestron eyepiece filters can be used with most telescopes from most manufacturers

.96 Inch:	#1A Skylight, #12 Yellow, #21 Orange, #23A Red, #38A Blue,#56 Green, #80A Blue, #96 50% or 25% Neutral Density
1¼ Inch:	#1A Skylight, #8 #12 #15 Yellow, #21 Orange, #23A #25 Red, #38A Blue, #47 Violet, #56 #58 Green, #80A #82A Blue, #96 50% 25% or 13% Neutral Density

Any of the above filters	each **12.95**
Any Four Filters	**47.95**
.96 or 1¼ inch Polarizer	**14.95**
LPR A 1¼" eyepice	**58.95**
LPR B (rear cell)	**89.95**

C90 SPOTTING SCOPES

3½" 1000mm F/11
Use as a spotting scope telescope or camera lens
Includes: 33x eyepiece, 8x20 erect finder, 45° erect prism, fitted carrying case.

C90 Basic	**329.95**
C90 MC with multicoated optics	**366.95**
C90 Rubberized Multicoated	**403.95**
C90 Rubberized Multicoated with 1¼ inch accessories	**433.95**
Camera Adapter (requires T-mount)	**31.95**
Eyepieces: 10, 16, 18, 25, 40mm Kellner	**32.95**
Eyepieces; 4,5,6,7,9,12mm	**43.95**

C90 VALUE PACK

Celestron Mini Tripod 62x Eyepiece
Camera adapter with choice of T-adapter **$84**

focus camera, inc.
4419-21 13th Ave, Brooklyn, NY 11219

THESE ADVERTISED PRICES ARE VALID **MARCH 10 - APRIL 10, 1992** SUBJECT TO PRODUCT AVAILABILITY
ORDERS ONLY CALL **800 221-0828** INFORMATION & NY STATE CALL (718) 436-6262
ORDER STATUS & CUSTOMER SERVICE **(718) 871-7608** 24 HOUR FAX LINE **(718) 436-1518**

Orders Shipped Promptly - Mastercard, Visa, Discover gladly accepted without surcharge. You may use your American Express card. All orders are subject to verification & acceptance. Shipping handling & insurance are additional, please call/write for exact details. 14-day money back guarantee (less shipping) provided merchandise is returned in new condition, unused as received with papers & packaging intact. **We gladly accept and reply to written or faxed inquiries.** Not responsible for typographical errors. These advertised prices are only available whilst supplies last. This ad supercedes all previous ads. Hours: Mon-Thurs 9-7, Fri 9-2, Sun 10-6.

WE DO NOT STRIP SCOPES - WE DO NOT DISPARAGE OUR COMPETITION - ALL OUR TELESCOPES INCLUDE FULL USA WARRANTY AND ARE SHIPPED COMPLETE WITH ALL ACCESSORIES AS SUPPLIED BY THE MANUFACTURER

Fly
aboard every Shuttle
through the pages of
Countdown
Magazine

Tired of searching for in-depth coverage of the space program? Enjoy the complete picture of every Shuttle flight and each major space advancement in ***Countdown*** magazine. Each month, ***Countdown*** puts you aboard with full, timely mission previews and reviews and photos found nowhere else. Since 1983, ***Countdown*** has provided a complete chronicle of the Shuttle program.

☆ ***Countdown*** covers it all ☆

- **Full-color flight photos!**
- **Contains no advertising**
- **Free issue guarantee:** If you are not fully satisfied with your first issue, cancel and pay nothing--no questions asked.
- **Limited-time offer** for new subscribers:

40% off the cover price
You pay *just $24.95*
for 12 monthly issues

Free Bonus:
Enclose payment with your order and receive a copy of ***On Orbit: The First Space Shuttle Era*** for free. ***On Orbit***, by the editors of ***Countdown***, provides a flight-by-flight chronicle of the development of the Space Shuttle.
On Orbit **is a $9.95 value —It can be yours for free!**

Send order to:
Countdown
Dept. 126
Main Stage Publications, Inc.
P.O. Box 216
Athens, OH 45701

Please enter my subscription to *Countdown*:
One year (12 issues) for $24.95
($40 foreign, $65 overseas Air Mail)

___ Payment enclosed ___ Please bill me later
(U.S. funds only, please)

Name____________________

Address____________________

City_______________ State_______

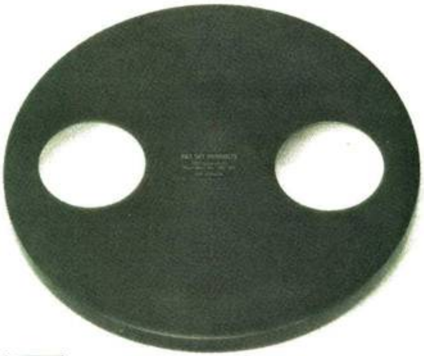
Zip__________

New Products

1 New aus Jena Binoculars

Europtik announces the availability of the German-made aus Jena 8x56B and 15x60B Nobilem Series binoculars. Both models are suitable for low-light viewing and feature fully multi-coated optics and prisms made from glass manufactured at the aus Jena plant. Both binoculars are water resistant and come with a felt-lined hard leather case. The 8x56 model has a field of view of 6.7° while the 15x60 has a 4.6° field. They weigh 44 ounces and 52 ounces respectively.

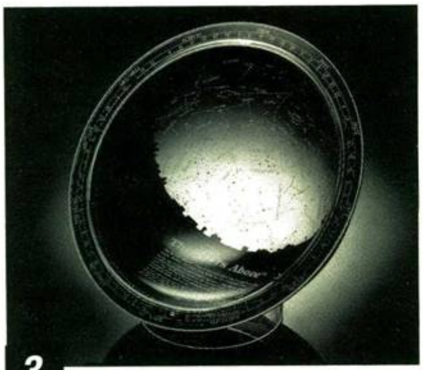
Europtik, Ltd., P.O. Box 319, Dunmore, PA 18512, (717) 347-6049. 8x56B: $810, 15x60B: $995. Write for a free catalog and list of aus Jena dealers.



2 A Novel Focusing Aid

"Kwik Focus" is an anodized aluminum lens cap with twin holes that fits over the aperture of a Schmidt-Cassegrain telescope. When the scope is aimed at a star or planet, the user sees a double image if the telescope is out of focus. When the images merge, the telescope is accurately focused. Kwik Focus is suitable for visual use and for astrophotography, either prime focus or eyepiece projection. Models are available for telescopes from 8 to 14 inches in aperture. Conventional aluminum lens caps are also available.

P&S Skyproducts, 20095 Concession Road 7, Mt. Albert, Ontario, Canada L0G 1M0, (416) 473-1627 (evenings). 8-inch model: $49.95, 10- or 11-inch model: $59.95. $4 shipping and handling.



3 A Domed Planisphere

The Stars Above planisphere is fashioned from two 14-inch-diameter acrylic hemispheres that can be adjusted to show the sky for any time of night or any night of the year. All the constellations are indicated, as well as first- and second-magnitude stars and the Milky Way. Also available but not shown is the Astro Disk, a similar planisphere but one made of flat acrylic disks.

Black Forest Observatory, 12815 Porcupine Lane, Colorado Springs, CO 80908, (719) 495-3828. The Stars Above, non-illuminated model: $74.95, illuminated model: $89.95, Astro Disk, 13-inch model: $39.95, 9-inch model: $29.95. Call for shipping costs and for 50-page catalog (free in the United States).

4 New Astronomy Videos from the A.S.P.

"Planet Flybys" is a 35-minute collection of computer-animated sequences of space-probe images. "Where the Galaxies Are" is an 8-minute video written and narrated by Margaret Geller of the Harvard-Smithsonian Center for Astrophysics. It uses computer animation to provide a tour through the patterns of nearby galaxy clusters. A third video, "The Perfect Stargazer," is a 60-minute program that documents the current revolution in astronomy that started with the use of automated telescopes.

Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112. Planet Flybys: $33.95, Where the Galaxies Are: $32.95, The Perfect Stargazer: $29.95.

5 Palmtop Computer for Global Positioning

The XR4-P combines a Husky Hunter 16 palm-top computer with a Navstar XR4 receiver that can acquire signals from orbiting Global Positioning Satellites. These satellites allow users to fix their location on Earth accurately. The software package supplied allows the user to review all satellite functions and to store positional and point information.

Navstar Electronics, Inc., 1500 North Washington Blvd., Sarasota, FL 34236, (800) 486-6338, FAX: (813) 366-9335. Call for pricing.

6 Magellan Slide Set

This set of 20 slides from the Magellan spacecraft's survey of Venus includes radar images of surface features as well as a view of Magellan's launch from the space shuttle and a diagram illustrating the radar-imaging technique. A 24-page booklet accompanies the slides.

Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112. Magellan Slide Set: $24.95. California residents add sales tax. Outside the United States, please add $4 postage and remit in U.S. funds.

7 An Upgrade for Dobsonian Mounts

Designed by amateur astronomer William E. Kelley and known as the BKD Device, this upgrade for Dobsonian mounts is now available as a commercial product. The product consists of a spring-loaded bearing plate and azimuth pin that installs between the ground board and the rocker box. The result is said to be improved smoothness and ease of adjustment of a Dobsonian mount's azimuth motion, especially noticeable at high power. Models are available for Coulter Odyssey telescopes of all sizes. These can also be adapted to similar-sized homemade telescopes.

Hydro-Abrasive Machining, Inc., 8831 Miner Street, Los Angeles, CA 90002, (213) 587-1342, FAX: (213) 587-1814. BKD Kit for the following Odyssey telescopes: 8-inch, $29.95; 10.1-inch, $32.95; 13.1-inch, $37.95; 17.5-inch, $42.95. Shipping and handling extra.

8 Sapphire Optics for Professional Applications

Available from Meller Optics are custom-fabricated sapphire optics that feature extreme surface hardness for use in harsh environments. Typical parts include lenses, domes, windows, and prisms.

Meller Optics, Inc., 120 Corliss Street, P.O. Box 6001, Providence, RI 02941, (800) 821-0180 or (401) 331-3717, FAX (401) 331-0519. Literature and price quotations provided upon request.

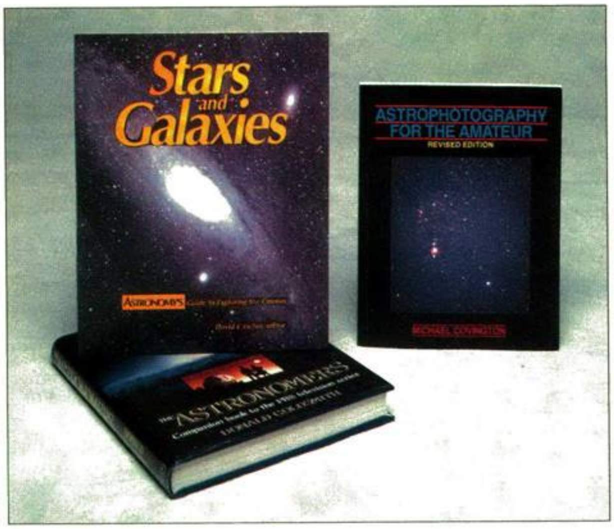
METEORITES
Buy•Sell•Trade
ROBERT A. HAAG METEORITES
Send $5.00 for your 64 page, full-color, brand-NEW Field Guide of Meteorites. Cost refundable with first purchase. Authenticity 100% *guaranteed.*
P.O. Box 27527, Tucson, AZ USA 85726

KITES
FREE COLOR CATALOG
Choose from over 200 exciting kites.
- Many unusual & innovative designs.
Call or write for your catalog today!
Into The Wind • **(800) 541-0314**
1408-A Pearl St., Boulder, CO 80302

ECLIPSE
JUNE 30, 1992
MONTEVIDEO
Air only from $1,060
Air/land Inclusive from $1,460 pp
Argentina, Brazil, Chile Add-Ons
TERRA NOVA TOURS
(213) 252-9347
(800) 782-5734

Deep-Sky Guides
Most complete telescopic guides ever produced! Includes: Astrophotos Visual Descriptions, Eyepiece Impressions, Findercharts, and Object Data to Mag. 14
The Observer's Guide
1-Canes Venatici
2-Ophiuchus
3-Sagittarius
4-Cygnus
5-Taurus
6-Orion
7-Leo
8-Scorpius
9-Hercules/Lyra
10-Peg/Androm.
11-Gemini
12-Mon/Lep/CMi
13-Coma Ber.
14-Aquila/Scutum
15-Cepheus
16-Cetus
17-Auriga/Lynx
18-Canis Major
19-Virgo, Pt. 1
20-Virgo, Pt. 2
21-Vul/Sge/Del
22-Cassiopeia
23-Perseus
24-Ursa Major
25-Hydra/Pyx
26-Draco/UMi
To be published: Subscription $15.
27-Aqu/Cap/Lac
28-Eridanus/For
29-Psc/Aries/Tri
30-Canc/Puppus
31-Cor/Ctr/Sext
32-Boo/CBr/Lib
Complete set of 32 "Guides" – $79.00
One - $3.50., three or more – **$3.00**ea.,
15 or more – **$2.75**ea., 25 or more – **$2.50** ea.
USA shipping free, Foreign add 15% or 25% air.
Index Card Finder Charts – $7.50 ea.
Set 1-The Messier Objects, Set 2-Finest NGC Objects, Set 3-Finest Double Stars, Set 4-NGC-Part B, Set 5-NGC for Larger Scopes (8" min.)
Observer's Logbook with 100 forms – **$18.95**
Space Special Galaxies, Planets, 100 slides – **$32.95**
SHIPPING: USA add 10% (Min. $1.50-Max. $10.)
CANADA-Add 15%, OTHER COUNTRIES–Add 15% surface or 25% airmail (Min. $2.50)
FREE CATALOG of Astronomy & Space Slides, Videotapes, etc.–USA .52c stamp, Foreign $1.
The Observer's Guide
P. O. Box 35, Natrona Heights, PA 15065 USA
Phone (412) 295-4128

ASTRONOMY SKYMART



What's New

The Astronomers A companion to the PBS series, ***The Astronomers*** is an immensely readable voyage to the stars. With clarity and wit, the author provides a sweeping look at the most important astronomical discoveries of the century, as well as the people who shape our understanding of the universe today. By Donald Goldsmith. 7$^{3}/_{4}$ x 9$^{1}/_{2}$, 332 pgs., 67 b&w and 36 color photos, 33 illus., sftbd. #30255/$24.95

Astrophotography for the Amateur Capture the beauty of the universe on film. Learn how to take pictures of stars, galaxies, planets, the Moon, the Sun, comets, meteors and eclipses using readily available equipment. Chapters cover getting started, advanced techniques and utilizing equipment. By Michael Covington. 7$^{3}/_{4}$ x 9$^{1}/_{2}$, 168 pgs., 96 b&w and 34 color photos, 47 illus., sftbd. #30256/$16.95

Stars and Galaxies: *Astronomy*'s Guide to Exploring the Cosmos A collection of 36 deep-sky articles from ***Astronomy*** magazine, ***Stars and Galaxies*** introduces the brightest, most beautiful and most challenging citizens of the Milky Way Galaxy and beyond. A companion to ***The Universe From Your Backyard***, which took you on a constellation-by-constellation tour of the sky, ***Stars and Galaxies*** focuses on regions rich in deep-sky objects. Edited by David J. Eicher, Associate Editor of ***Astronomy***. 8$^{1}/_{2}$ x 11, 192 pgs., 225 photos, 120 illus., hrdbd. Available March 1992. #18536/$29.95

Astro Library

BOOKS AND VIDEOS

BEGINNER

1992 Exploring the Universe Calendar Celebrate each month with a dramatic full-color 14 x 11 astrophoto or painting. A monthly essay tells of celestial events while "The Planets this Month" column lets you know when and where to find the planets. From the publishers of ***Astronomy***. #68066/$9.95

Atlas of the Solar System Provides the most up-to-date information on all aspects of the solar system. Written in encyclopedic style with over 700 photos, illustrations and diagrams plus numerous maps and tables. By Patrick Moore and Garry Hunt. 463 pgs., hrdbd. #30235/$17.99

Astrophotography A clearly written guide for the beginner. By Barry Gordon. 2nd Ed. 208 pgs., sftbd. #30125/$19.95

The Backyard Astronomer's Guide Advance to a new level in this irresistible vocation. With the help of how-to information and numerous illustrations, this guide explains what equipment to buy and which techniques enhance your telescope's performance. By Terence Dickinson and Alan Dyer, Associate Editor of ***Astronomy***. 9 $^{1}/_{2}$ x 11 $^{1}/_{2}$, 296 pgs., hrdbd. #30254/$39.95

Cambridge Atlas of Astronomy A beautiful reference with data and photos from recent space missions and a thorough description of all aspects of modern astronomy. By Jean Audouze & Guy Israel. 14 $^{1}/_{2}$ x 10 $^{1}/_{2}$. 2nd Ed. 432 pgs., hrdbd. #30123/$90.00

Color Star Atlas The friendliest star atlas ever! Shows all naked-eye stars in beautiful color. Ideal for naked-eye, binocular, small telescope and armchair astronomers. 20 wide-field maps and an informative introduction. By John Cox and Richard Monkhouse. 40 pgs., sftbd. #18038/$19.95

Cosmos Based on Carl Sagan's award-winning television series, combining the history of astronomy with a view of mankind and our relationship to the universe. Each chapter corresponds to the related televised episode. By Carl Sagan. 365 pgs., hrdbd. #30248/$34.95

Cosmos Video Series and Book Contains seven, two-hour videotapes, each containing two episodes of the Cosmos series. Also includes the corresponding book, ***Cosmos***, described above. By Carl Sagan. Book is 325 pgs., sftbd. Videos by Carl Sagan Productions, Inc., 2 hours each, VHS. #30249/$199.98

The Creation of the Universe Host Timothy Ferris takes you from the Big Bang 15 billion years ago to the frontiers of science today. By PBS Home Video. 92 min. #50000V/$19.95

The Discovery of our Galaxy The author re-creates the lives and temperaments of the great astronomers who have helped to discover the Milky Way. By Charles A. Whitney. 308 pgs., sftbd. #30250/$14.95

Exploring the Southern Sky A lavish book of images from the European Southern Observatory in the Chilean Andes. With photos of Supernova 1987A, Halley's Comet and a 4-foot panoramic poster of the Milky Way. By Svend Lausten, Claus Madsen and Richard M. West. 274 pgs., hrdbd. #30236/$45.00

In the Stream of Stars Celebrates a collaboration between Soviet and American space artists with nearly 200 colorful works of space art accompanied by an informative caption. Also includes a historical perspective by Ray Bradbury. Edited by Hartmann, Sokolov, Miller & Myagkov. 183 pgs., hrdbd. #30247/$29.95

The Light Hearted Astronomer A wickedly funny story of buying a telescope and becoming an amateur astronomer. By Ken Fulton. 115 pgs., sftbd. #18001/$7.95

Moon Map This 39 x 26 map shows over 500 features on the near side of the Moon, including landing sites of Surveyor and Apollo spacecraft. New Edition. #30068/$14.95

Nightwatch Learn a new, simple method of identifying stars, planets, constellations and nebulae. Covers backyard observing, stargazing equipment, the planets and eclipses. By Terence Dickinson. 160 pgs., hrdbd. #30229/$34.95

Objects in the Southern Sky Twenty colorful slides of deep-sky objects from the European Southern Observatory in the Chilean Atacama desert with a detailed explanation of each slide. Produced by the European Southern Observatory. #30241SET/$25.00

The Observer's Sky Atlas Basic guide to the night sky for both the novice and experienced observer. With 50 star charts that include stars visible with the naked eye, binoculars or small telescope. By Erich Karkoschka. 130 pgs., sftbd. #30237/$14.95

Astro Library

CONTINUED

The Quick Reference Guide to *Astronomy* Magazine 1973-1990 A subject listing for easy access to articles, photos and features in ***Astronomy*** magazine. By Jack Hobart. 75 pgs. #30226/$8.00

Rainbows, Halos & Glories Discusses well-known phenomena such as sun pillars, sun dogs and mirages. Contains over 200 illustrations, including color photos, plus detailed figures to help better understand these mysteries. By Robert Greenler. 195 pgs., sftbd. #30243/$22.95

Space Places A unique portrait of how far we have traveled and what lies ahead in space exploration. Lavishly photographed and insightfully written. By Roger Ressmeyer. 208 pgs., hrdbd. #30232/$45.00

Sunsets, Twilights and Evening Skies Covers the spectrum of sunsets and evening skies as documented through the personal experiences of the authors. Observations span several years, with quite an accumulation of color photos and notes. By Aden & Marjorie Meinel. 163 pgs., sftbd. #30244/$19.95

Turn Left at Orion The first guidebook for small telescopes, highlighting the Moon, planets and deep-sky objects. Ideal for beginning amateur astronomers. By Guy Consolmagno and Dan M. Davis. 205 pgs., hrdbd. #30245/$24.95

INTERMEDIATE

Atlas of Deep Sky Splendors, Fourth Edition A collection of wide-field photographic charts especially designed to help you pinpoint faint objects in the night sky. By Hans Vehrenberg. 242 pgs., hrdbd. #30242/$59.50

Build Your Own Telescope Instructions for building five amateur telescopes. By Richard Berry. 276 pgs., hrdbd. #30124/$25.95

The Cambridge Encyclopedia of Space The most complete account of the conquest of space ever published. Opens with the vivid history of space exploration and includes all aspects of space technology and science. Edited by Michael Rycroft. 386 pgs., hrdbd. #30228/$79.50

Deep-Sky Observing with Small Telescopes An anthology that describes hundreds of deep-sky objects to view with small backyard telescopes. By David J. Eicher, Associate Editor of ***Astronomy***. 336 pgs., sftbd. #30188/$29.95

Discover the Stars Introduction to star watching with naked eye, binoculars or a telescope; contains monthly star maps and 23 charts. By Richard Berry. 119 pgs., sftbd. #30155/$12.95

Sky Atlas 2000.0 The best general purpose star atlas for the backyard observer. By Wil Tirion. 26 charts, 16 x 11. #30022/$39.95

Thunderstones and Shooting Stars A guide to meteorites that explains the history, make-up and types of meteors. By Robert T. Dodd. 196 pgs., sftbd. #30227/$12.95

Touring the Universe Through Binoculars The most extensive listing yet of deep-sky objects visible through binoculars. An excellent manual and field guide for amateur astronomers. By Philip S. Harrington. 294 pgs., sftbd. #30238/$27.95

Universe William Shatner narrates this award-winning NASA film on our modern understanding of the universe. 28 min. #50001V/$29.95

The Universe From Your Backyard Dave Eicher leads a tour of 46 constellations, highlighting 690 of the finest deep-sky objects. By David J. Eicher, Associate Editor of ***Astronomy***. 188 pgs., sftbd. #18037/$29.95

Voyager: Missions to Jupiter and Saturn A summary of Voyager's exploration of Jupiter, Saturn, and their satellite and ring systems. From NASA's Jet Propulsion Lab. 20 min. #50002V/$24.95

Voyager: Neptune Encounter Highlights This fascinating video collects 21 short films produced at NASA's Jet Propulsion Lab in connection with the Voyager 2 flyby of Neptune in August 1989. 33 min. #50003V/$29.95

ADVANCED

Amateur Astronomer's Handbook Comprehensive coverage of telescopes and accessories. By J. B. Sidgwick. 572 pgs., sftbd. #30018/$9.95

Comets: A Chronological History of Observation, Science, Myth and Folklore A full range of comet fact and fiction, explaining their basics. Includes the only catalog of all cometary apparitions up until the year 1700. By Donald K. Yeomans. 485 pgs., hrdbd. #30240/$35.00

How to Build Your Own Observatory Reprints from ***Telescope Making*** explain how to build 17 backyard observatories. 3rd Ed. 81 pgs., sftbd. #18004/$9.95

How to Make a Telescope How to grind, polish and test the optics for a Newtonian telescope, plus tips on mountings. By Jean Texereau. 2nd Ed. 424 pgs., hrdbd. #30048/$19.95

The Hubble Atlas of Galaxies Photos illustrate Edwin Hubble's famed galaxy classification. From the Carnegie Institution of Washington. 51 pgs., hrdbd. #30231/$39.95

Introduction to Astronomical Image Processing The first how-to guide to CCD image processing for the IBM - PC and compatibles. Includes software and test images. By Richard Berry. 96 pgs., sftbd. #30239/$29.95

The Meteorite & Tektite Collectors Handbook Learn to identify, preserve and display meteorites and tektites while mastering composition, structure and classification. 38 photos, 24 drawings and 25 tables. By Philip M. Bagnall. 170 pgs., hrdbd. #30252/$24.95

Observing Handbook and Catalogue of Deep Sky Objects Detailed guide with descriptions of 2,000 galaxies, star clusters and nebulae. Includes helpful charts and a catalogue. By Christian B. Luginbuhl and Brian A. Skiff, 352 pgs., hrdbd. #30246/$49.50

Planetary Nebulae: A Practical Guide and Handbook for Amateur Astronomers For many years, the nature of planetary nebulae remained a mystery. Now find out how our current understanding has been derived. Includes a catalogue of 1340 planetary nebulae and 253 finder charts. By Steven J. Hynes. 270 pgs., sftbd. # 30253/$24.95

Uranometria 2000.0 A star atlas that plots 250,000 stars and thousands of deep-sky objects. By Wil Tirion, Barry Rappaport & George Lovi. 565 pgs. total, hrdbd. **Vol. 1**: The Northern Hemisphere to -6° declination, #30156/$39.95; **Vol. 2:** The Southern Hemisphere to +6°. #30157/$39.95

To Order:

CALL TOLL FREE, 24 HOURS A DAY (800) 533-6644

Please have your credit card ready. Or use the ***Astronomy*** order form bound into this magazine. Include for postage and handling: U.S. $3.00; Canada and foreign add 18% (min. $4.00). Wisconsin residents add 5% sales tax. Canadian orders add 7% GST to total. Prices and availability subject to change. Payable in U.S. funds.

Kalmbach Publishing Co., Dept. AC032, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612

Dept. AC042

So close...it's almost as if you're on the moon.

Astroscan® 2001 WIDE FIELD Telescope

Astroscan Telescope User's Manual

SAVE $60 on our world-famous Astroscan® telescope. The easiest-to-use-and-enjoy family telescope.
#AJ2001 $329
Reg. $389
Limited time offer expires 12/31/92

The Stargazers Choice Reach out and explore the night sky. Unique award-winning design allows you to cradle it in your arms or it glides smoothly and solidly into its table-top base. Highlights of this scope are its extra wide 3° field and its superb light-gathering ability with large 4⅛" clear aperture to resolve panoramic vistas. Optional image erector adapts scope to view land objects. Focuses 25 feet to infinity. System is sealed to protect against dust and moisture and is permanently collimated at the factory.
Astroscan 2001: Includes telescope, base, 28mm RKE® eyepiece, finder sight, dust cap, carry strap, 36 page instruction book and our 36 page sky guide.
A wide assortment of accessories are also available.

Lick Observatory Photograph

Economical First Telescope
The Edmund 3" F/6 Reflector
Edmund Designed and Engineered

3" Reflector Telescope #AJ31,308 $199.95
3" With Image Erector #AJ31,639–$279
Adventure in the night sky. The wide 1.6° field makes it easy to find sky objects, the 30X magnification with 15mm RKE® eyepiece is ideal for both the moon and deep sky objects. The heart and pride of our 3" F/6 system is the professional-grade optics, ground and polished in our own manufacturing facility from the finest optical glass components.

the Edmund RKE® Breakthrough

8mm	#AJ30,820
12mm	#AJ30,940
15mm	#AJ30,819
21mm	#AJ30,941
28mm	#AJ30,787

(specify) $48.95

Our moderately priced, three-element system outperforms designs using four or more optical elements. The exclusive design of the RKE® eyepiece family coupled with the quality of its optics admits more light, is free from false color and offers a sharply-focused, wide-field view.

Order direct. For phone orders call (609) 573-6250, all major credit cards. Call 24 hours a day. 45 day unconditional guarantee or money refunded in full.
Please include $2.50 for postage and handling.

Edmund Scientific

FREE 188 PAGE CATALOG
Includes a wide selection of telescope components for the avid astronomy enthusiast interested in building telescopes—in stock for immediate delivery.

SERVING ASTRONOMERS SINCE 1942
Edmund Scientific Co.
Dept. 10B1, N964 Edscorp Bldg., Barrington, NJ 08007

Meetings & Events

April 10-11
Spring Spectacular Star Party, Lemon Lake County Park, Crown Point, Indiana. Sponsored by the Calumet Astronomical Society. Phone: (219) 845-9174.

April 10-12
4th International Dark-Sky Association Meeting, Hotel Park, Tucson, Arizona. Contact: IDA, 3545 North Stewart Avenue, Tucson, AZ 85716.

April 24-25
46th Annual Astronomical League North Central Regional Convention, Pewaukee, Wisconsin. Sponsored by the Milwaukee Astronomical Society. Contact: Dan Koehler, W248 S7040 Sugar Maple Drive, Waukesha, WI 53186. Phone: (414) 662-2987.

April 27-May 2
Texas Star Party, Prude Ranch, near Fort Davis, Texas. Hosted by the Southwest Region of the Astronomical League. Contact: TSP registrar Bobby Braley, P. O. Box 386, Wylie, TX 75098.

April 29-May 2
Middle Atlantic Planetarium Society Conference, Carnegie Science Center, Pittsburgh, Pennsylvania. Phone: (412) 237-3308.

May 9
Astronomy Day. Contact Gary Tomlinson, Astronomy Day Coordinator, Public Museum of Grand Rapids, 54 Jefferson SE, Grand Rapids, MI 49503. Phone (616) 456-3987.

May 22-24
Southern Star Astronomical Convention. Sponsored by the Charlotte Amateur Astronomers Club. Contact: Harold Melvin, 418 School Circle, Harrisburg, NC 28075.

May 29-31
Jersey Star Quest III, United Methodist Camp, Browns Mills, New Jersey. Sponsored by the Amateur Astronomers Association of Princeton, Inc. Contact: Greg Mauro, P. O. Box 731, Princeton, NJ 08540. Phone: (609) 490-3560.

May 30-June 7
2nd Annual Grand Canyon Star Party, Grand Canyon National Park, Arizona. Sponsored by the Tucson Amateur Astronomy Association. Contact: TAAA, 1122 East Greenlee Place, Tucson, AZ 85719.

ANOTHER PLEASED ASTRONOMY ADVERTISER

"ASTRONOMY magazine is very important to Celestron as an advertising medium."

Alan R. Hale, President
Celestron International

To find out how advertising in ASTRONOMY can impact your sales, call Greg Swan or Cathy Odland today.

(800) 558-1544

CELESTRON INTERNATIONAL
2835 Columbia St. Torrance, California 90503
Telephone: (213) 328-9560
Fax: (213) 212-5835

Dear ASTRONOMY:

ASTRONOMY magazine is very important to Celestron as an advertising medium since it is the largest magazine for the astronomy hobbyist. So important that for many years we have continually committed to the most expensive space (the back cover) plus inside pages.

The editorial portion of the magazine is of superb quality and the graphics are second-to-none.

Yours truly,

Alan R. Hale

Alan R. Hale
President
Celestron International
Torrance, California

ASTRONOMY
Your primary media buy.

Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612, Fax (414) 796-0126

Tired of just looking at pictures?

Then come to Scope City and see first-hand what you've been missing.

Scope City, the world's largest and most complete telescope and binocular discount centers, offers you telescopes for: **astronomy, sports, land/sea, view-homes,** and **photography**, as well as a huge selection of binoculars at discount prices.

On the other hand, if you're unable to visit us, we'll send you our catalog . . . *Yes, it has more pictures.*

Scope City/Mail Order Dept.
P. O. Box 440
Simi Valley, CA 93065
Info. & ordering in CA (805) 522-6646
National Toll Free (800) 235-3344

Scope City
TELESCOPES • BINOCULARS • SPORT OPTICS

BUY • SELL • TRADE • SERVICE

AUTHORIZED MEADE APD DEALER

SIMI VALLEY, CA
679 Easy St.
(805) 522-6646

TORRANCE, CA
3132 Pac. Coast Hwy
(310) 326-3251

COSTA MESA, CA
3033 S. Bristol
(714) 957-6900

RIVERSIDE, CA
10076 Magnolia Ave.
(714) 359-5591

LAS VEGAS, NV
2216 Paradise Rd.
(702) 733-9288

SHERMAN OAKS, CA
14324 Ventura Blvd.
(818) 789-5805

SAN DIEGO, CA
4766 Clairemont Mesa Blvd.
(619) 277-6686

SURPLUS STORE
Simi Valley, CA
679 Easy St.
(805) 522-6646

June 5-12
Beginning Astronomy Camp for Teens, Tucson, Arizona. Contact: Lisa Roubal or Kim Dow, Arizona Alumni Association, 1111 North Cherry, Tucson, AZ 85721. Phone: (800) 232-8278 (outside Arizona) or (602) 621-5233.

June 12-13
22nd Annual Apollo Rendezvous and Telescope Fair, Dayton, Ohio. Sponsored by the Miami Valley Astronomical Society and the Dayton Museum of Natural History. Contact: Ian Dumbauld, 5932 Culzean Drive, Apt. 706, Dayton, OH 45426. Phone: (513) 837-4600.

June 19-21
Astronomical League Mid-States Regional Convention, Avila College and Powell Observatory, Kansas City, Missouri. Sponsored by the Astronomical Society of Kansas City. Contact: Jackie Wade, M-S Chairman, 11305 King Street, Overland Park, KS 66210. Phone: (913) 469-0135.

June 19-26
Advanced Astronomy Camp for Teens, Tucson, Arizona. Contact: Lisa Roubal or Kim Dow (see June 5-12 entry).

June 20-25
Universe '92, University of Wisconsin, Madison, Wisconsin. Presented by the Astronomical Society of the Pacific and ASTRONOMY magazine. Contact: Wisconsin Meeting Information, Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112. Phone: (415) 337-1100.

June 23-24
The Universe in the Classroom, Madison, Wisconsin. Contact: Astronomical Society of the Pacific, Teachers' Workshop Information, 390 Ashton Avenue, San Francisco, CA 94112.

July 1-5
General Assembly of the Royal Astronomical Society of Canada, Calgary, Alberta. Contact: RASC-Calgary Centre, c/o Ms. Dennis Goodman, 28 Southland Crescent SW, Calgary, Alberta, Canada T2W 0K3. Phone: (403) 252-7095. ☐

Please submit announcements at least four months before the date of the meeting or event.
When you write to organizations listed in Meetings and Events, include a self-addressed, legal-sized envelope with your request for information.

ADORAMA

42 West 18th Street • New York, NY 10011

ORDER TOLL FREE 800-223-2500
ORDERS & INFO 212-741-0052
FAX # 212-463-7223

TELESCOPE ACCESSORIES

LUMICON

UHC PREMIUM FILTERS		DEEP SKY PREMIUM FILTERS			
1 1/4"	99.50	.96"	59.50	1 1/4"	79.50
48mm f/most 2" EP	199.95	2"	119.50	48mm	119.50

H-BETA				OXYGEN III			
1¼"	99.50	48mm	199.50	1¼"	99.50	48mm	199.50

SOLAR FILTER
By Thousand Oaks Optical
GLASS TYPE 2 Stainless Steel Coated MOUNTED

3.1"	61.95	4"	71.95	5"	92.95
6"	99.95	8"	119.95	10"	129.95
11"	149.95	12.5"	169.95	14"	199.95

THREADED SOLAR FILTERS TYPE 2

49mm-58mm	61.95	62mm-67mm	68.95	72mm-77mm	73.95

JIM'S MOBILE

DEC. MOTOR		FOCUS MOTOR	
f/Meade LX3/5/6/MTS	74.50	f/Meade LX3	78.50
for Celestron 8	74.95	f/Meade LX4/6	78.50
f/Meade Gem	79.95	f/Meade Newt	89.95
		f/Celestron 8	78.95
DSC-Max	499.95	NGC-Max	789.95
NGC Mini Max	569.00		

TELRAD

Finder with Mounting Base	42.95
Spare Mounting Base	8.95
Dew Shield for Telrad	11.95

IDAI MIRRORS

IDAI 4.5" f/7.8 (860mm focal leng.) w/Matching Elliptical Flats	64.95
IDAI 5" f/8 (980mm focal leng.) w/Matching Elliptical Flats	89.95

MEADE PARABOLIC MIRRORS

6" f/8	139.95	8" f/6	194.95	10" f/4.5	389.95
6" f/5	139.95	10" f/6	389.95	12.5" f/6	579.95

MEADE ELLIPTICAL FLAT SECONDARY MIRRORS

1.3"	26.95	1.83"	37.95	2.6"	53.95
1.52"	35.95	2.14"	45.95	3.1"	84.95

MEADE RACK & PINION FOCUSER

#67 1 1/4"	45.	#640 1 1/4"	69.	#680 1 1/4"	89.

CAMERA FOCUSING SCREENS & ACCS

beattie

BEATTIE INTERSCREEN PLUS
(4x Brighter)

f/Nikon F/F2/F3	88.95	f/Olympus OM1,2,3,4	53.95
f/Nikon FE/FE2/FM/FM2/FA	53.95	f/Canon T-90	64.95
f/Canon EOS	64.95	f/Nikon 8008	59.95

OLYMPUS

All Matte (1-8)	21.95	Varimagni Finder	69.95

PUBLICATIONS

Sky Atlas 2000.0 Color	44.95	The Night Sky	2.95
Sky Atlas 2000 Field	16.95	Atlas of Deep Sky Splendors (4th Ed.)	15.95
Uranometria 2000.0 Vol 1 or 2	39.95	Night Watch by T. Dickinson	26.95
Bright Star Atlas 2000	11.95	The Guide to Amateur Astronomy (327 p)	26.95
Sky Catalog 2000.0 Vol 1 or 2	34.95	Astrophotography by Barry Gordon	15.95
Norton's Sky Atlas *18 Edt*	36.95	Astrophotography II by Patrice Martinez	19.95
Edmnd Mag 6 Star Atlas	16.95	Manual of Advanced Celestial Photography	42.50
Celestron Sky Maps	15.95		
Passport To The Stars	49.95		
Explore The Sky w/Binocs	3.95		

BINOCULARS

How to choose Binoculars
By Alan Hale
President of Celestron .$13.95

SWIFT
GIANT

Observer 11x80 BCF	242.00
Satellite 20x80 BWCF	249.0

SPOTTING SCOPES

Telemaster 15-60x60	209.95
Searcher 20x40x60 (12.6")	236.95
Seeker 80mm (32X)	229.95

STEINER

7x50 G	429.00
8x56 MGA	582.95
10x50 G	416.95
15x80 G Observer	804.95
15x80 C Observer w/Cmp.	972.95
24x80 Telescop.	589.95

ZEISS
W/O CASE

8x56 CF GA	859.95
15x60 CFT GA	1319.95
30x60 BGAT	989.95
Motor Foc f/30x60	169.95

FUJINON MT-SX

7x50 MT-SX w/cs	328.95
10x70 MT-SX w/cs	406.95
14x70 MT-SX w/cs	428.95
15x80 w/Tripod	2899.95
25x150 w/Tripod	7399.95
25x150 RA w/Mount Trpd	8999.95

KOWA SPOTTING SCOPES
w/20-45x zoom

TSN-1	589.95	TSN-2	574.95
TSN-3	929.95	TSN-4	899.95

CELESTRON
GIANT
NEW MULTI-COATED

11x80 MC	299.00
NEW 15x80	309.00
20x80 MC	314.00
Solar Filter f/11x80,20x80	69.95
LPR filter set f/above.	99.95
Car Window Mount	69.95

ULTIMA SERIES

7x42	173.	8x32 w.a.	173.
7x50	239.95	10x42w.a.	189.
10x50	189.	8x56	185.95

PRO SERIES

8x30w.a.	119.	7x50	119.
10x50w.a.	119.	12x50w.a.	159.
8-24x50	199.95		

NEW VIXEN
SUPER GIANT

30x80	399.
20x100	*ONLY* 899.

NIKON

7x50 SPHP w/cs	509.95
10x70 HP w/case	459.95

FIELD SCOPES

20-45x60 Zoom	344.95
20-45x60 ED Zoom	549.95

SPOTTING SCOPES

20x60 Spotter R/C	162.95
15-45x60 Spotter R/C	247.95
20x Eyepiece	46.95

SWAROVSKI

8x56 SL	Call
10x50 SL	Call

BINOCULAR ACCS

Car Window Mount	34.95
Tripod Adapter	14.95

CELESTIAL INNOVATIONS

Binocular Support System f/Giant Binoculars	109.95

Vixen

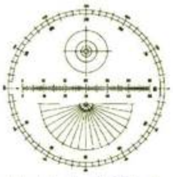
TELESCOPES

Vixen #9117 Telescope

#9117 4½" Newtonian with Equatorial Mount
- 900mm fl, f/7.9
- 2 eyepieces –18mm (50X) –8mm (112x)
- 6x30 Finderscope
- Adjustable Aluminum Tripod 299⁹⁵

#9115 4½" Newtonian Alt-Azimuth Mount
- 900mm fl, f/7.9
- 2 eyepieces –18mm (50X) –8mm (112x)
- 6x24 Finderscope
- Adjustable Aluminum Tripod 244⁹⁵

Celestron's Micro Guide Eyepiece



Features a laser-etched reticle **with built-in cordless illuminator** with adjustable brightness control. The eyepiece is a MC 12.5mm Orthoscopic that can easily be viewed even with eyeglasses.
Guiding with conventional dual-crosshair reticles often forces the user to slightly defocus the guide star to prevent it from suddenly being "hidden" behind the broad grooves - greatly reducing the limiting magnitude. Due to the finely etched lines in the Micro Guide, much fainter, sharply focused stars can be "captured" as guide stars with no reduction in limiting magnitude. 139⁹⁵

Celestron Photographic Tripod Deluxe Slow Motion Controls

By using the Celestron Deluxe Slow Motion Controls between your lens/ spotting scope and your photographic tripod, you will have accurate slow motion adjustment in elevation and azimuth (Up-down / left-right).
The Deluxe Tripod Slow Motion controls fit on top of any standard photo tripod and have a large stable base with a standard size 1/4x20 mounting screw. (CNSMC) 44⁹⁵

New Celestron 500/5.6

Features: Fast **f/5.6**, Short **8.5"**, Light (2 lb.11oz.), Multi Coated optics, with built-in flattener, focuses down to 5', can be used as a telephoto lens with the addition of a T-mount or as a 90mm spotting scope with the addition of a 45° 1.25" image erector and 1.25" ocular. case included. 289⁹⁵
NEW f/4 converter f/500/5.6 109.95

COUNTERWEIGHT BAR ASSEMBLIES FOR C8 & C11

Consists of a metal rod that runs the length of the telescope tube with 2 counterweights that may be moved along the length of the bar for better dynamic balancing.
Models are available for 8" and 11".

Counterweight 8"	69.95
Counterweight 11"	79.95

Fujinon FMT-SX Binoculars

10x70

The "F" stands for "flat field" and that means the sharpest, most accurate, high resolution images obtainable from any binoculars available today.
The new flat field models incorporate 23mm "eye-relief" the world's longest– you see the complete image even when wearing glasses. "SX" binoculars are up to 25% brighter than every other high quality binocular. Outstanding brightness factor of 95%. Built to US military specifications, the aluminum alloy housings are waterproof, dry nitrogen filled.

6x30 FMTR-SX with Rubber Coatings	359.95
7x50 FMT-SX with Carry Case	378.95
7x50 FMTR-SX w/Rubber Coating	427.95
7x50 FMTR-CSX R.C.with Compass	497.95
8x30 FMTR-SX Rubber Coated	369.95
10x70 FMT-SX with Carry Case	457.95
16x70 FMT-SX with Carry Case	567.95
New Starscope image intensifier night vision scope(f/.2)	2249.95
Tripod Adapter	14.95

Close Out on Discontinued Celestron Accessories

36mm Plossl 1.25"	54.95
Drive Correction Dual Axis f/original C8	99.95

SEE OPPOSITE PAGE FOR ORDERING INSTRUCTIONS

ADORAMA

42 WEST 18th STREET • NEW YORK, NY 10011
CUSTOMER RELATIONS • 212-741-0466 • Mon–Thur. 9–4:30, Sun. 11-2 ET

FAX #
212/ 463-7223

PHONE ORDERS ACCEPTED
DAY OR NIGHT
MON–THURS. 9 TILL 9:30 PM EST
FRI. 9-1:45 • SUNDAY 9:30–6

STORE HOURS:
MON.–THURS. 9–7pm
FRI TO 1:45 • SUN 9:30–5:45

ORDER TOLL FREE • US & CANADA
800-223-2500
ORDERS & INFO
212-741-0052

COMPLETE with MANUFACTURER'S ACCESSORIES

Meade®

THE LEADER'S EDGE

"SMART DRIVE" SCHMIDT- CASSEGRAIN TELESCOPES

This month we are offering the famous Meade 8" Scmidt-Cassegrain 2080 Model 40 at a greatly reduced price

The **2080 model 40**, includes the following features:
- 8" f/10 optical tube with MCOG • LX6 SMART Drive
- Powered 3 ways (1) AC (2) 12V DC (3) AA battery pack
- Electronic control center • Wedge & field tripod
- Finder, scope, star diagonal, 26mm super Plossl.

All this for only **$1299.95**

To Top-It-Off You can buy the following accessories at tremendously low prices (only when purchased together with the 2080-40)

8" Digital readout system #9068	**229.95**
Electronic focuser #1200A	**149.95**
6.7 ultra wide eyepiece	**119.95**
#50 Accessory case	**49.95**

2080 BASIC

2080A Basic 8" Schmidt Cassegrain Telescope. Drive, Wedge & Tripod **916.95**

2045-D 4" SCHMIDT CASSEGRAIN

Fork Mount, Drive, N/S Switch, DC Operation, 1-1/4" S.D. 25mm Eyepiece, 5x24 Finder	**599.95**
Field Tripod & Wedge for 2045	**234.95**
Carry Case for 2045	**99.95**
Dew shield #582	**54.95**
#126 2x Short Tube Barlow	**46.95**
Piggyback Bracket	**17.95**
Tube Weight Ring	**49.95**

DIGITAL SETTING CIRCLES / C.A.T.

Digital Readout System for LX6 & Premier Series	**249.95**
C.A.T. f/8" or 10"	**699.95**

MEADE EYEPIECES

Super Plossl	Ultra Wide	Super Wide
6.4, 9.7, 12.4, **72.95**	4.7mm **129.95**	13.8mm **109.95**
15, 20, 26 ...... **59.95**	6.7mm **134.95**	18mm **109.95**
32, 40mm **79.95**	8.8mm (1 1/4, 2") **159.95**	24.5mm **112.95**
56mm (2") .. **158.50**	14mm (1 1/4 ,2") . **189.95**	32mm (2") . **164.95**
Barlow 2X Series 4000 ... **62.95**		40mm (2") **229.95**

Orthoscopic Series 2 Eyepieces 4,6,9,12.5,18, 25mm 1/4" ... **45.95**

MEADE TELESCOPE ACCESSORIES

Accs. Case #50	**66.95**	#908 Nebular Filter 1 1/4"	**74.95**
Accs Shelf for Tripod	**24.95**	#911 Nebular Filter	**86.95**
2X Barlow 1.25" #122	**43.95**	Dec #38, #39	**@ 88.95**
Variable 2X,3X 1.25 #127	**54.95**	Hand Ctrl. #36	**82.95**
Wide Field Adapt Sys	**99.95**	Dew Shield (2080)	**99.95**
2" Star Diag w/1.25" Adapt	**129.95**	Dew Shield (2120)	**119.95**
Off Axis Guider Assm	**153.95**	Piggy Bk Brkt 2080/2120	**31.95**
Illum Reticle E.P. 1.25"	**84.95**	Tube 1401 Weight Set	**74.95**
45° Erect Prism	**49.95**	Tube 1402 Weight	**79.95**
Elect Focuser #1200A	**179.95**	Tele Extender	**29.95**
Photo Visual Filt Set 6 pc.	**79.95**	Tele Compressor Sys	**56.95**
#1A Sky Filter	**44.95**	9x60 Polar Illuminated Finder w/Bracket	**143.95**
#910 Nebular Filter 2"	**99.95**		

DEEP SPACE REFLECTOR TELESCOPES

DS-10A 10" Reflector **629.95**

REFRACTOR & REFLECTOR TELESCOPES

226 60mm Altazimuth w/2 Eyepiece	**119.95**
290 60mm Equatorial	**199.95**
290W 60mm Equatorial w/3 Kellner Eyepieces & 6x30 Finder	**269.95**
826 C 8" Newtonian	**819.95**

312 80mm Altazimuth Complete with slow motion controls, setting circles, full length wood tripod 5x24 new finder, 1¼" Diagonal Prism, 25mm 1¼" eyepiece (36x) All for only **399.95**

323 80mm Equatorial	**429.95**
Basic Camera Adapter 1 1/4"	**34.95**
Variable Projection Camera Adapter 1 1/4"	**49.95**
Motor Drive 323 & 4420	**88.95**
4420 4.5 Reflector. w/Equatorial Mount	**309.95**

97E with MCOG 3.5" (90mm)SPOTTING SCOPE

97E 90mm Cassegrain Mirror/Lens with MCOG, Made in USA, 1000mm Focal Length with 45° erect image .96" prism, 5x21 viewfinder, 25mm (40x) eyepiece

With Carry Case **All for only** **319.95**

97ER as above with rubber coating	**339.95**
2045S Spotting Scop	**419.95**

BUSHNELL

BAUSCH & LOMB DISCOVERER

DISCOVERER with 15-60x Zoom	**168.95**
Discoverer Case	**44.95**
Tamrac Case for Discoverer	**19.95**
Camera Mount	**14.95**
Car Window Mount	**34.95**

Bausch & Lomb 800mm Mirror Spotting Scope

800 f/10 Compact Unit (only 8" long) **239.95**

SPACEMASTER (60mm)

Spacemaster	**129.95**
Spacemaster Rubber Armored	**146.95**
Spacemaster with 15-45x, Tbl Trpd. and Case	**219.95**
Spacemaster Waterproof w/15-45x	**259.95**

SPACEMASTER II (70mm)

Spacemaster II	**164.95**
Spacemaster II with 15-45x, Tbl Trpd. and Case	**234.95**

Spacemaster 60/70 Access.

15, 20, 25, 40 & 60x EP.	**34.95**
22x Wide Angle	**46.95**
15-45x Zoom Eye Piece	**79.95**
Camera Mount	**29.95**

BAUSCH & LOMB ELITE

Waterproof & Multi Coated

ELITE Rubber Coated with 15-45x Zoom Eyepiece	**314.95**
ELITE Rubber Coated with 22x Eyepiece	**259.95**

Tele Vue®

NEW PLOSSL

55mm 2"	**Call**
40, 32mm 1 1/4"	**Call**
26, 21, 17, 13mm 1 1/4"	**Call**
10.5, 7.4mm, 1 1/4"	**Call**

WIDEFIELD

40mm 2"	**Call**
32mm 2"	**Call**
24mm 1 1/4"	**Call**
19mm 1 1/4"	**Call**
15mm 1 1/4"	**Call**

BARLOW

2.5X, 1.8X 1 1/4"	**Call**
Big Barlow 2x 2"	**Call**

NAGLER

20mm Type 2; 2"	**Call**
16mm Type 2; 2, 1 1/4"	**Call**
12mm Type 2; 2, 1 1/4"	**Call**
13mm 2" & 1 1/4"	**Call**
9mm 2" & 1 1/4"	**Call**
7mm 1 1/4"	**Call**
4.8mm 1 1/4"	**Call**

NEW PANOPTIC

22mm 1¼"	**Call**
35mm 2"	**Call**
Panoptic Barlow Interface 2"	**Call**

ACCESSORIES

2" Star Diagonal	**Call**
Rich Field Kit w/New 55 Plossl 2" S.D., Adapt, 2" to 1 1/4" Adapt	**344.95**
1¼" E.P. Adt. f/Questar	**59.95**

PARACORR COMA CORRECTORS

1 1/4"	**169.95**
2"	**279.95**

TELEVUE REFRACTORS

GENESIS 4" (101mm) f 5 Fluorite APO The Ultimate Refractor .... **Call**

GENESIS OUTFIT includes complete scope w/2" Mirror, 26mm ploss carry case and Celestron's Super Polaris Equatorial Mount, Polar Axis Scope, with Illuminator all for only **1949.95**

RENAISSANCE 4" f 5.5 Brass Refractor	**Call**
SOLARIS (req. T Scanner)	**Call**

NEW PRONTO 70mm Aperture 450mm Focal Length f/6.4 w/ED Glass

The PRONTO performance stands right by the top names in the industry at a fraction of the cost. Available in 2 versions.

FREE Tele Vue 15mm wide field w/Purchase of **NEW Tele-Vue Pronto**

PRONTO w/2" star diagonal & 21mm Plossl	**Call**
PRONTO w/1.25" erect prism & 21mm Plossl	**Call**

MOUNTS & ACCESSORIES FOR TELEVUE REFRACTORS

TV Panoramic w/Wood Tripod Alt-Azimuth Mount	**339.95**
NEW Panoramic mount w/alumin. tripod	**284.95**
New Tele Pod Alt Azimuth Mount	**229.95**
Tele Vue Equatorial System Mount w/Wood Tripod, Adpt.	**799.95**
New! **Starbeam** . "Red Star" Projection Finder	**Call**
New! **Piggy-Cam** .Camera Adapter	**Call**

Edmund Scientific

Astroscan 2001 288.95

Edmund Scientific's affordable wide-field, go-anywhere telescope gives super bright images.

RKE Eyepieces 1 1/4"	**39.95**	R.A. Prism Erector	**51.95**
8.4-21 Zoom Ortho	**96.95**	Variable Cam. Adapt	**69.95**
2.5 Rke Barlow	**66.95**	Tripod Bracket	**43.95**
Variable Barlow	**36.95**	Carry Bag	**32.95**
Straight Image Erctr	**59.95**	Sun Screen	**49.95**

3" f/6 Reflector **179.95**

TELESCOPE ACCESSORIES

DEW SHIELD

Collapsible, fold down easy to store and transport

for Celestron C90	**18.95**
for Meade 2045	**18.95**
f/8" Schmidt Cassegrains	**28.95**
f/10" Schmidt Cassegrains	**38.95**

Heavy Duty Rechargeable DC Power Pack

5 Amp Unit	**69.95**
12 Amp Unit	**89.95**

CELESTRON 2", 1¼" & .96" EYEPIECE FILTERS

(Not all filters available in .96" & 2")

Avail. in the following colors: 1A Skylight; 8 Yellow; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 38A Blue; 47 Violet; 56 Light Green; 58 Green; 80A Light Blue; 82A Pale Blue; ND 0.3; ND 0.6; ND 0.9

.96" & 1.25"	**Each 11.95**
2"	**Each 26.95**
Buy any 4 filters (.96"or 1.25")	**for only 39.95**
2" 4 filter set	**84.95**
Polarizer 1 1/4	**14.95**

CELESTRON®

SCHMIDT CASSEGRAIN TELESCOPES

New Ultima 8 P.E.C. (Periodic Error Correction)	**1849.95**
New Ultima 11 P.E.C. (In Stock 4 Pcs. at time of print)	**3099.95**
NEW lens shade 11"	**149.95**
Focus Motor for Ultima P.E.C.	**99.95**
DEC Motor for Ultima P.E.C.	**99.95**
New Powerstar 8 P.E.C.	**1524.95**
CLASSIC 8 with SBC	**999.95**
Adjustable Tripod Rubberized with Leg Support	**229.95**
Quartz Drive Corrector for Classic	**219.95**
Super Polaris C8	**939.95**
Super Polaris C8 with Starbright Coating	**1149.95**
Single Axis Drive for Super Polaris	**156.95**
Dual Axis Drive for Super Polaris	**254.95**
New Single axis A.C. Drive	**89.95**

8" f/10 Schmidt Cassegrain Black Optical Tube Assembly with 5x24 Finder, 25mm 1.25", Star Diagonal 1.25", Footlocker Case ......only **$549.95**

ADVANCED ASTRO MASTER

New Advanced Astro Master (f/fork mounted C8s & SP Mounts) ... **554.95**

NEW COMA CORRECTOR

With 1¼", 2" Eyepiece & Focus Adapter **189.95**

REDUCER CORRECTOR

f/6.3 Focal Reducer Corrector .... only **144.95**

Multi Function Focal Tester 5S

Focus on & off the optical axis at 3,16,22 & 30mm Diam. in a single setup .... **only** 159.95

RADIAL GUIDER

Allows free movement of guider while camera is fixed.. **119.95**

Micro guide eyepiece 139.95

6mm Illum. Reticle w/moveable reticle **144.95**

REFLECTOR TELESCOPES

Super Polaris 6" (SPC 6)	**719.95**
C4.5" Newtonian	**429.95**
Motor Drive f/C4.5 Comet Catcher	**167.95**
Polar Axis Finder w/Illum f/C6, CC, C4.5	**52.95**
Polar Axis Finder w/Illum f/SP Mounts	**74.95**
Tele Extender Refractor/Newtonian	**44.95**

REFRACTOR TELESCOPES

Super Polaris C102 102mm	**1042.95**
Super Polaris C102 Fluorite	**2199.95**
Firstscope 80 w/45 Erect Prism	**457.95**
Firstscope 80 Brass	**799.95**
New Super Polaris 80mm (SPC 80)	**608.95**
T Adapter Refractor/C4.5	**32.95**
Tele extender refractors	**39.95**
60mm Altazimuth	**119.95**
60mm Equatorial	Only **189.95**
Correct Image Eyepiece f/60mm Ref	**9.95**
T Adapt/Tele Extender f/60mm Ref	**43.95**

SPOTTING SCOPES

All the C90s Include: 8x20 Erect Image Finder, 45° Erect Image Diagonal, 30mm, .96" E.P., Foam Fitted Case

C90 .... **334.95** C90 MC	**367.95**
C90 Rubber MC	**404.95**
New **C90MC w/1.25" Accs.**	**434.95**
New **C90MCRC w/1.25" Accs.**	**484.95**
C65 Rubber Coated	*SPECIAL* **119.95**
C60 Rubber Coated	**169.95**
Zoom Master II	**209.95**
SS-80 w/45° Erector, 18mm 1.25" E.P.	**289.95**
New S-55F Fluorite 440mm f8	**489.95**

CELESTRON C90 & SPOTTING SCOPE ACCS.

Barlow .96, 2x	**33.95**	Diag Prism 45° .96	**47.95**
5,6,7,9,12 Ortho, .96	**36.95**	1.25" Diag Prism 45° .for C90	**49.95**
Barlow .96" 2.5x	**24.95**	Series 5 Filter Set	**59.95**
10,16, 18, 25, 30, 40 Klnr.96	**32.95**	Skylight Filter #1	**34.95**
Mult Ocular .96 Hold	**49.95**	T Adapt. C90	**30.95**
Porro Prism .96	**44.95**	Shoulder Mount	**64.95**
Image Corrector 1.25" f/C90	**29.95**		

CELESTRON TELESCOPE ACCS.

New Improved Accs Cs	**44.95**	Porro Prism 1 1/4"	**54.95**
Barlow 1 1/4" 2x	**41.95**	Series 6 Filter Set	**56.95**
Barlow 2" 2x	**89.95**	New Star Diag 1 1/4 MC	**47.95**
Barlow Lens 1.25" 3X	**32.95**	New Improved 2" Mirror Star Diagonal w/1.25" Adapt.	**159.95**
Counterwt Bar Assm 8"	**114.95**	**Super Polaris 8" Mount with Polaris Finder**	**499.95**
Counterweight Set 8"	**59.95**	Sky Filter #2	**39.95**
DC Inverter	**78.95**	2" Prism Diagonal	**269.95**
45 Erect Prism 1 1/4"	**52.95**	2" Mirror diagonal	**149.95**
Dewstar/Shade 8"	**27.95**	Adj. Tripod Rubberized	**224.95**
8x50 RA Pol Find C8	**154.95**	Tele Extender	**29.95**
Focus Motor 11, 14	**119.95**	T. Adapter 6x6	**59.95**
LPR #A (f/1.1/4" E.P.)	**54.95**	T. Rings medium format	**159.95**
LPR #B (Rear Cell)	**69.95**	Wheels f/Adj Tripod	**39.95**
LPR Filter #C (f/2" E.P.)	**109.95**	Vibration Suppr. Pads	**44.95**
Mult Ocular Hldr 1 1/4"	**124.95**	Wedge f/C8	**87.95**
Piggyback Mt 8"	**36.95**	New Tilt -Plate 0°	**79.95**
Piggyback Mt SPC6/C80/C102	**39.95**		
Polarizer Filter Assm	**89.95**		
Polarizer Set 1 1/4"	**49.95**		

CELESTRON MYLAR SOLAR SCREEN FILTERS (MOUNTED)

f/60 Ref	**43.95**	f/C90s	**69.95**	f/C90s Rlc	**79.95**
f/c4.5	**69.95**	f/C102	**84.95**	f/C8s	**114.95**

CELESTRON 1¼" EYEPIECES

5, 6, 7, 9, 12mm, Ortho	**49.95**	25mm Kellner	**39.95**
Zoom Ocular (8.4-21mm) Ortho	**108.95**		

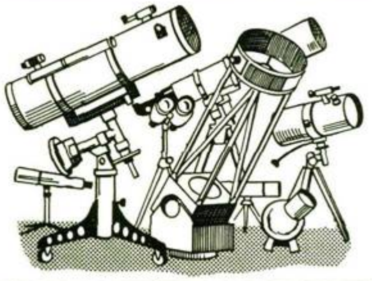
NEW ULTIMA EYEPIECES

5, 7.5, 12.5, 18, 24mm, 1 1/4"	**62.95**		
30, 35, 42mm 1¼"	**88.95**	15,19,23mm W.A. 1¼"	**112.95**
45, 60mm 2"	**166.95**	80mm 2"	**259.95**
Ultima 2X Barlow	**63.95**		

WE SHIP PROMPTLY. ALL TELESCOPES INCLUDE U.S.A. WARRANTY

No Surcharge for MasterCharge or Visa Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or driver's license for reference. Shipping, handling and insurance additional. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealer's license #802862. Pictures are for illustration purposes only and may not be exact. **Prices effective till April 3, 1992** **Please address all inquiries and orders to ASTRO. DEPT. #55**

TELESCOPES
For Sale At
HALF PRICE!



World's LARGEST Classified Shopper for Telescopes, Binoculars, Cameras & Accessories for Astronomy

ONLY $20

- *HUNDREDS* of current ads each month for name brand equipment at garage sale prices!
- Sent via *FIRST CLASS MAIL*

- *SUBSCRIBE RISK FREE:* Save the cost of your subscription the first time you buy something or your money back! Call today!

Advertise Free
Pay when you Sell or Trade
(4% Commission)

Mention this ad and get 13 issues for $20!

The Starry Messenger
PO Box 6552-A Ithaca, NY 14851
(201) 992-6865
(Canadian residents send $25 US funds)

PRECISION ELLIPTICAL DIAGONALS

Manufactured in our own factory. Always in stock for immediate delivery. All diagonals are AL SiO coated and are shipped postpaid.

Minor axis	Price
1.00"	$22.95
1.30"	$28.95
1.52"	$36.95
1.83"	$45.95
2.14"	$62.95
2.60"	$81.95
3.10"	$104.95
3.50"	$199.95
4.00"	$259.95
4.50"	$405.95
5.00"	$440.95

LASER INTERFEROGRAM INCLUDED

Made from fine Annealed Pyrex® Brand Glass

We welcome your custom orders. Custom optics up to 36" diameter. Call, write or fax your inquiries today.

PIRATE INSTRUMENTS
28073 Diaz Rd., Ste. D
Temecula, CA 92590
(714) 694-5876 • Fax (714) 694-5878

Readings & Resources

Beyond the Big Bang (page 30)

The Big Bang by Joseph Silk, (W. H. Freeman and Co., revised 1989). An excellent introduction to the standard Big Bang model.

The Big Bang Never Happened by Eric Lerner, (Times Books/Random House, 1991). A popular-level introduction to the controversial plasma universe model.

Lonely Hearts of the Cosmos by Dennis Overbye, (Harper/Collins, 1991). If you have interest in cosmology and the Big Bang theory, you'll love this book.

Kitt Peak (page 38)

Realm of the Long Eyes, by James Kloeppel (Univelt, Inc., 1983) is a brief history of Kitt Peak National Observatory, telling how this facility was conceived and built.

Lunar Rays (page 80)

Atlas of the Moon by Antonín Rükl, (Hamlyn, 1990). Superb lunar atlas by a master cartographer; every Moon observer should have a copy.

The Geologic History of the Moon by Don E. Wilhelms, (U.S. Geological Survey Professional Paper 1348, 1987). Best up-to-date survey of lunar geological history.

Lunar Sourcebook by Grant Heiken, David Vaniman, and Bevan French (Cambridge University Press, 1991). An excellent summary of lunar knowledge for the professional scientist, but containing summary chapters fairly accessible to lay readers.

Building Owl Observatory (page 82)

"Build a Backyard Observatory" by Steven Chomniak, ASTRONOMY, June 1989. This simple observatory features a roll-off roof and can be built in several weekends

How to Build Your Own Observatory, reprinted from issues of *Telescope Making* magazine (Kalmbach Publishing Co., 1988). Seventeen observatories, from simple shelters to roof-top structures, are featured in this do-it-yourself guide.

CREDITS

Cover: NASA Apollo 17 frame M-2444; ***inset:*** Jorge Soto, 200mm f/4.5 lens, 200 ASA film from Playas de Tijuana, Baja California, Mexico; ***p. 4:*** Joe Reed, 300mm f/16 lens, Ektachrome 100 film, 1/250-second exposure from 200 miles south of Ensenada, Mexico; ***p. 13:*** Jean Dragesco; ***p. 20:*** NASA/JPL; ***p. 22:*** NASA; ***p. 26:*** NASA; ***p. 28, left:*** NASA/Japanese Institute of Space and Astronautical Science; ***p. 28, bottom right:*** Hank Brandli; ***pp. 30-31:*** illustration by Steve Davis, included photos from front to back: Abell 1060 galaxy cluster © 1983 Royal Observatory Edinburgh; New Technology Telescope deep plate © European Southern Observatory; field of distant galaxies courtesy Anthony Tyson; ROSAT satellite image of galaxy cluster X-ray emission courtesy NASA; ***p. 32-33:*** illustration by Steve Davis based on a survey map © 1989 Smithsonian Astrophysical Observatory and courtesy Margaret Geller and John Huchra; ***p. 34-35:*** illustration by Steve Davis; image of galaxies courtesy Anthony Tyson; ***p. 36-37:*** Computer simulation images courtesy James Gelb, MIT; ***pp.38-39:*** courtesy NOAO; ***p. 39-43:*** David Bruning; ***p. 41:*** illustration by Patti L. Keipe; ***pp. 52-55:*** Gerrit L. Verschuur; ***p. 60:*** Darla Gawelski; ***p. 68, left:*** Bob Yen, 8-inch f/10 SCT, 1-angstrom H-alpha filter, Tech Pan 2415 film from La Jolla, California; ***pp. 68-69:*** Phil Lohmann, 800mm f/6.7 lens with a 1.4x teleconverter, Kodacolor Gold 100 film from San Diego, California, no filter; ***p. 70, top:*** Dewey Vanderhoff, 500mm f/8 lens, Ektar 125 film, 1/500-second exposure with no filter from San Diego, California; ***bottom:*** Patrick Macnamara, 500mm f/5.6 lens with a 2x teleconverter, Ektar 125 film, 1/1000-second exposure with no filter from San Diego, California; ***p. 71, top left:*** Steve Edberg, 5-inch SCT at f/10, 1/2-density orange mylar filter, Kodachrome 200 film, 1/4-second exposure; ***top right:*** Tony Dunn, 35mm-70mm zoom lens at 70mm from San Diego, California; ***middle left:*** Jorge Soto, 200mm f/4.5 lens, 200 ASA film from Playas de Tijuana, Baja California, Mexico; ***bottom left:*** Alan Nelson, 500mm f/6 lens with a 2x teleconverter, ND4 filter, Ektar 100 film, 1/125-second exposure from San Diego, California; ***pp. 82-87:*** all photos by Jim Krick, illustrations by Lee Vande Visse; ***pp. 80-82:*** courtesy Lick Observatory; ***p.83, top:*** Jean Dragesco; ***bottom:*** Richard J. Wessling; ***p. 85, top:*** Martin Germano; ***bottom:*** Norman Carlson; ***p. 88:*** Edwin Faughn; ***p. 89, top:*** Don Parker, 16-inch reflector, ST-6 CCD camera, December 10, 1991; ***bottom:*** Matthew Boulton, 6-inch reflector at 213x, August 11, 1991; ***p. 90, top left:*** Gerald Rhemann, 6-inch refractor, hypersensitized Tech Pan film, 30-minute exposure on September 16, 1991; ***center:*** Charles Klimitchek; ***bottom:*** Don Parker, 16-inch reflector, ST-6 CCD camera, December 4, December 4, and December 10, 1991; ***p. 91:*** Peter Zaffo, all-sky camera, November 8, 1991; ***p.92:*** James Glen Pearson, 360mm f/6 lens, glass solar filter, Fuji Velvia film (ISO 140), 10 exposures at 5-minute intervals; ***p. 99:*** Darla Gawelski.

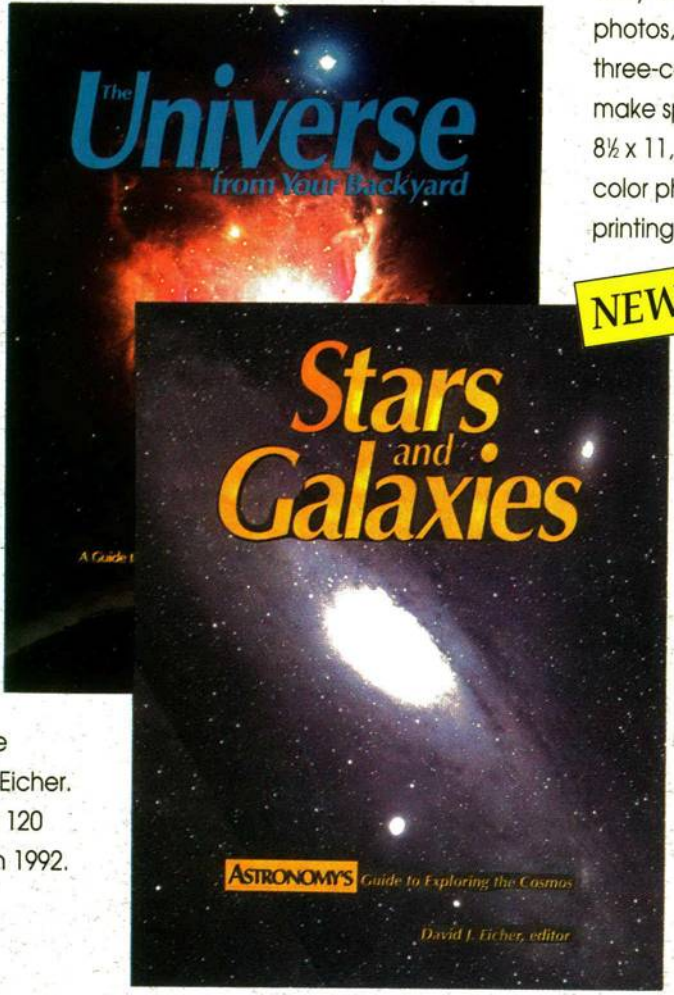
Peer deep into the cosmos from your backyard.

From the editors of ASTRONOMY

Two companion books from ***Astronomy*** magazine, along with anything from binoculars to a 17-inch Dobsonian telescope, allow you to explore the farthest reaches of the deep sky from your own backyard.

Stars and Galaxies, the new collection of 36 deep-sky articles from ***Astronomy***, describes in detail hundreds of the most beautiful, mysterious and challenging objects in the universe. Written by ten amateur astronomers, ***Stars and Galaxies*** helps you journey to the center of the Galaxy, learn the art of observing planetaries, locate legendary faint galaxies, and stalk the elusive Horsehead. Edited by Dave Eicher. 8½ x 11, 192 pgs., 225 photos, 120 illus., hrdbd. Available March 1992. #18536/**$29.95**

The Universe from Your Backyard takes you on a constellation-by-constellation tour of the sky. Highlighting 690 of the sky's finest deep-sky objects, ***Astronomy*** Associate Editor Dave Eicher transports you to the galaxies of the Great Bear, the star-crowded regions of the Sagittarius Milky Way and more. Spectacular photos, eyepiece drawings and a three-color map for each area make spotting the objects easier. 8½ x 11, 188 pgs., 50 b&w and 90 color photos, hrdbd. Now in its third printing. Available March 1992. #18037/**$29.95**


The Universe from Your Backyard
A Guide
Stars and Galaxies
ASTRONOMY'S Guide to Exploring the Cosmos
David J. Eicher, editor

NEW!

Together, these two books are handy next to a telescope and invaluable as practical references.

To order, call toll free, 24 hours a day

(800) 533-6644

Please have your credit card ready. Or use the order form bound into this magazine. Include for shipping and handling: U.S. $3.00, Canada and foreign add 18% (minimum $4.00). Wisconsin residents add 5% sales tax. Canadians add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

Kalmbach Publishing Co.
21027 Crossroads Circle
P.O. Box 1612
Waukesha, WI 53187-1612

Dept. A0518

THE BACKYARD ASTRONOMER
Journey to the Center of the Galaxy
by Phil Harrington
Mag 5.1 Size 24.9' M22 by John P. Gleason
Mag 3.3 Size 80' M7 by Martin C. Germano
Size 90' by 40' The Lagoon Nebula by Tony Hallas and Daph

ASTRONOMY
April 1992

Adorama 110, 111, 114
ARC Software 27
Astronomical Innovations 25
Astronomical Society of the Pacific 100
Astronomics 27
Bethany Sciences 12
BLUE SKY Pages 97, 98
Brazen Sky Productions 13
California Telescope Co 93
CEB Metasystems 72
Celestron International 44, 45, 116
City Camera 114
Coulter Optical Inc 94
Countdown 104
Cusick Telescopes 12
Edmund Scientific Company 108
Exclusive Travel 99
FC Meichsner Co 100
Focus Camera 102, 103
Fort Davis Astronomical Supply 101
Fremont, Jim 99
Haag, Robert A. - Meteorites 105
Image Checks 96
International Dark-Sky Assoc 17
Into The Wind 105
Jim's Mobile (JMI, Inc.) 21
Kalmbach - *Astronomy* 96, 109
Kalmbach - *Books* 17
Kalmbach - *Next Month* 114
Kalmbach - *Sky Mart* 106, 107
Kalmbach - *Stars & Galaxies* 113
Los Angeles Optical 95
Lumicon 66, 67
Meade Instruments 2, 3, 8, 9, 10, 11
Newbridge Communications 19
NordicTrack 17
Observatory Guide 105
Observatory Techniques 18
Optical Guidance Systems 93
Orion Telescope Center 14, 15
Oxford University Press 96
Parks Optical 72
Pirate Instruments 112
Questar 84
Reader's Exchange 98
Santa Barbara Instrument Group 84
Scope City 109
Seeside Engineering 18
Shutan Camera & Video 16
Sonye, Dan - Eclipse Data 18
Spectra Astro Systems 25
Star Bound 95
Starry Messenger 112
Tech 2000 18
Technical Innovations 101
Tele Vue Optics, Inc 7, 29, 115
Terra Nova Tours 105
Thousand Oaks Optical 101
Tuthill, Roger W. Inc 25, 99
Twilight Tours 13
University of Arizona Alumni Assoc 12
Vista Instruments 99
Wholesale Optics (Pauli's) 73
Wholesale Optics of Penn 95
Zephyr Services 23

COMING IN THE MAY 1992 ISSUE OF ASTRONOMY

MISSIONS TO THE EDGE If astronomers have their way, twin space missions early next century will explore the frozen realms of Neptune and Pluto.

A DIFFERENT KIND OF EARTH Had the Sun been just 50 percent more massive, the entire panoply of life on Earth would be remarkably different.

HUNTING FOR PLUTO With an 8-inch telescope and our detailed observing guide, you too can find this elusive world.

AVAILABLE ON YOUR NEWSSTAND APRIL 14

FREE CATALOG CALL 1-800-359-5085

CITY CAMERA

Quality Telescopes at Discount Prices!

DEEP SKY SPECIAL!
BUY A MEADE DS10A FOR
$749
AND GET A PAIR OF
OF MEADE 20x80
BINOCULARS
FOR **$99**
(reg. $249)
LIMITED QUANTITIES

CELESTRON COMPUSTAR 8
The world's best 8-inch modern telescope is now the world's smartest with a state-of-the-science astronomical computer capable of locating 600 objects in 30 minutes from an 8,000 object memory. LED's tell you an object's coordinates, brightness, angular size and more. High-tech stepping motor drives move the telescope to any object you select. Programmable, portable and personal. 2000mm focal length and 8-inch clear aperture provide superb optical performance.
INCLUDES TRIPOD & WEDGE
$2995

MEADE 2080A $995
8 INCH APERTURE
6 x 30 FINDER SCOPE,
TRIPOD,
WEDGE, 1.25 INCH STAR
DIAGONAL & 25MM
EYEPIECE

CELESTRON ULTIMA 8 PEC
$2099
ULTIMA 11 PEC
$3395
POWERSTAR 8 PEC
$1799
INCLUDES FREE
DEC & FOCUS
MOTORS

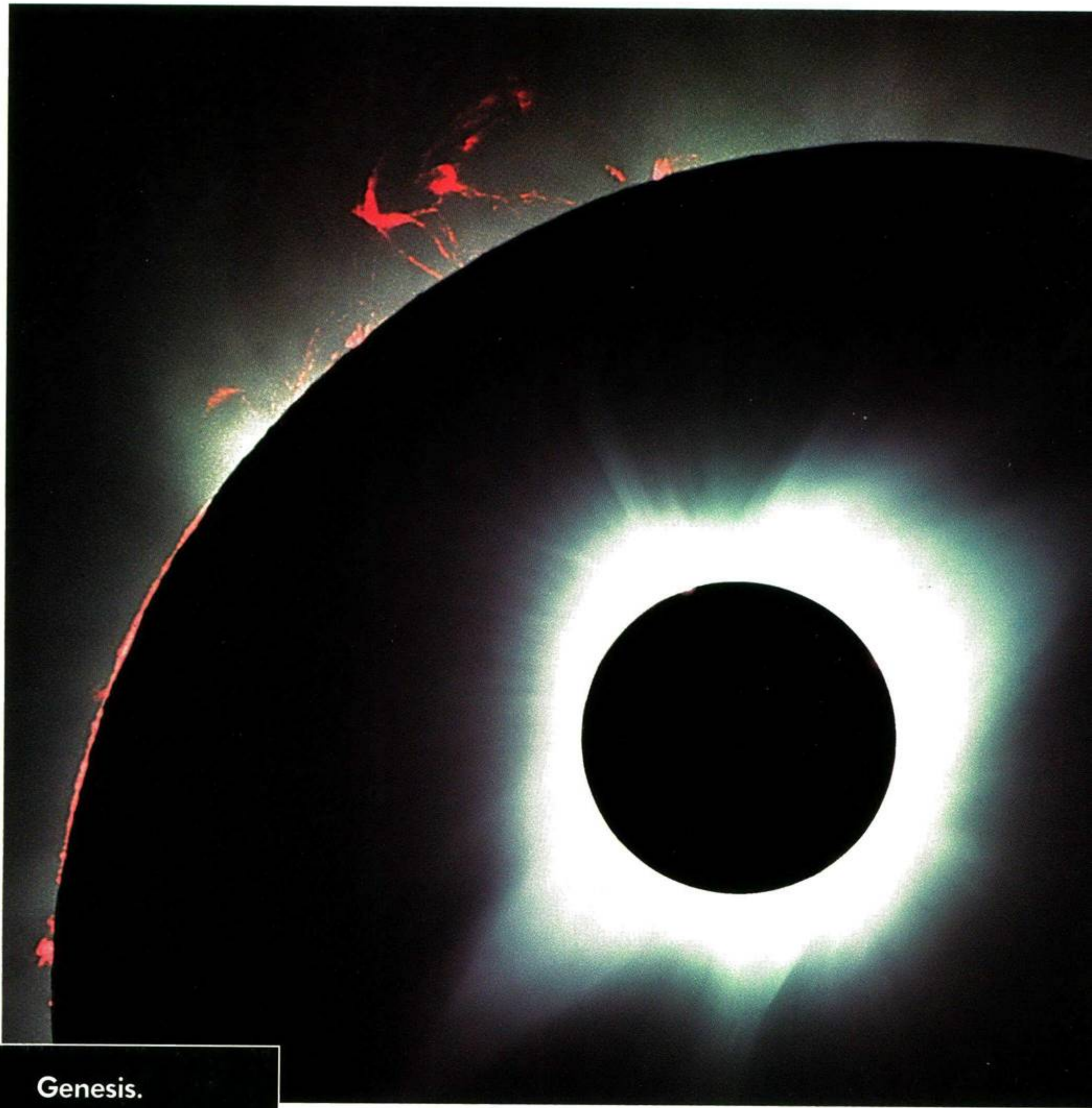
CELESTRON C4.5
$469
FREE SHIPPING IN U.S.!

MEADE 2045D
$649
FREE SHIPPING IN U.S.!

CITY CAMERA
15336 W. WARREN • DEARBORN, MICHIGAN 48126
ORDER LINE 1-800-359-5085
GENERAL INFORMATION 1-313-846-3922 / 24 HR. FAX 1-313-846-4450
HOURS: MON.-FRI 9:00 am - 6:00 pm • SAT. 9:00 am - 5:30 pm
ATTENTION CANADIANS
Come into our store and we will pay your Michigan sales tax on any telescope!
WE SHIP ONLY FIRST QUALITY FACTORY PACKED TELESCOPES.
ORDER BEFORE NOON EST AND WE WILL SHIP SAME DAY

Telescope specialist
Rewarding position for exp.sales person.
In depth knowledge of Astronomy
products. Telescope Repair a+.
Call Mr. Mendlowits 212-741-0401

GENESIS



Genesis solar photography by Joe Folmer.

Genesis.
Great Optics, To Go.

Whether you're traveling afar to an eclipse or simply backyard gazing, Genesis goes along without a struggle. It's lightweight, compact, a snap to set up, and equally friendly to use. Yet this 4" aperture, 500 mm f/5 fluorite refractor delivers a wide-field and tack-sharp universe. At 9x to 260x, it's even better than you imagined.

Tele Vue™

Send for full-line literature, please include $3 for postage and handling.
Tele Vue Optics, 20 Dexter Plaza, Pearl River, NY 10965. (914) 735-4044.

CELESTRON'S SP-C8

Deluxe Features—Down-to-Earth Pricing

Discover a **complete** 8" telescope with custom features yet decidedly non-custom price. A scope that can grow with you over the years. The SP-C8 comes with a limited lifetime warranty backing up our commitment to lasting quality.

SP-C8 OPTICS

Celestron's optics are unsurpassed in quality. We pride ourselves on having the most stringent quality control in the industry.

The SP-C8's optics are Starbright® coated. This proprietary optical multicoating greatly increases light transmission and improves contrast. The superiority of these optical coatings has been confirmed on sophisticated optical testing equipment.

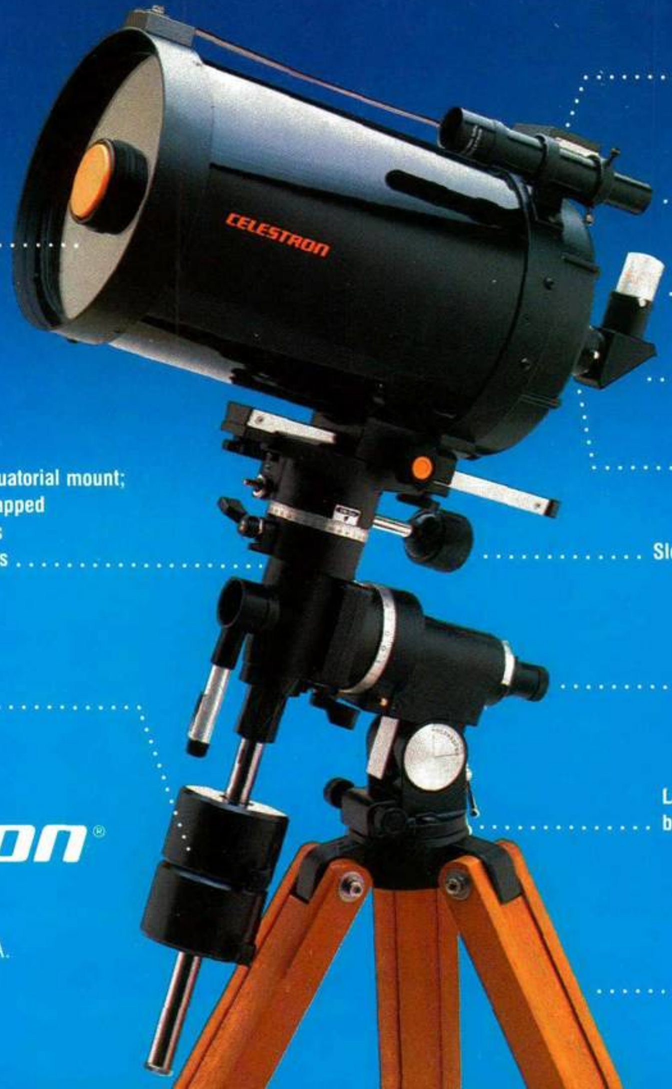
SUPER POLARIS MOUNT

The SP-C8's very sturdy, well-engineered German equatorial mount combines all the features pictured below.

Due to numerous requests, this mount is now available separately.

Its technically advanced gear system, stable tripod, plus many extras combine to make this mount an excellent investment—unmatched in performance at this price.

To see the Super Polaris C8, visit the Celestron dealer near you. Or write or phone Celestron for more information.


Piggyback mount
8" diameter, 2032mm focal length, f/10, Schmidt-Cassegrain
6x30 finderscope
Celestron's own Starbright® coated optics
CELESTRON
26mm Plössl multicoated eyepiece—1¼"
Multicoated star diagonal—1¼"
Visual back—1¼"
German equatorial mount; 144 tooth lapped worm gears in both axes
Slow motion controls
Adjustable counterweights
Built-in polar alignment scope for quick set-up
Latitude scale; bubble level
Adjustable wood tripod; (excellent vibration dampening)

CELESTRON®

Celestron International
2835 Columbia Street
Torrance, California 90503, U.S.A.
213/328-9560 800/421-1526
FAX: 213/212-5835
Telex: 182471